SERVICE MANUAL

MODEL FM144-10SXRII VHF FM MOBILE TRANSCEIVER

FOR MSSRS: AMATEUR WHOLES ELECTRONICS 御中

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SERVICE MANUAL KYOKUTO FM144-10SXRII

FM MOBILE TRANSCEIVER

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3. *VCO AND PLL ADJUSTMENT/ALIGNMENT*

1. *1MHz Oscillator calibration:* - Test Point, Pin 14, IC-2 PLL (SN7490)
   Equipment required: - Frequency counter

   Adjust C-30, PLL, 20pf trimmer so that frequency is accurate to at least 6 digits, i.e., 1.000,00MHz. See NOTE 1. for waveform and voltages of frequency divider chain.

2. *Alignment VCO 41.03 and 41.03166MHz Oscillator:* -
   Test Equipment required: - Frequency counter.
   Test point: - Hot end of secondary, L8, VCO (#7401)

   To facilitate later frequency checks and minimising resetting of frequency counter recommend measure frequency of 3rd harmonic, i.e., 121.09MHz and 123.0950MHz. Adjust L7 for stable oscillation zone (turn slug in approximately 1/3 turn for peak output position. Adjust L8 for maximum output. Adjust C-32 and C-33 for frequency; 41.03MHz and 41.03166MHz respectively. Adjust to at least ±0.5KHz accuracy.

3. *VCO Control voltage:* -
   Test equipment required: - VTVM
   Test Point: - PLL or VCO feedthrough capacitor with red lead.

   Adjust C-4, VCO 20pf trimmer to obtain 2V DC at 144.000MHz. Change setting of panel control MHz switch and confirm voltage rises smoothly. See Note 3.

4. *VCO output level:* -
   Test equipment required: - RF VTVM
   Test point: - VCO Output (VCO end of coax leading from VCO to RX and TX.

   Set front panel controls to center of band (145.000 for A type and 147.000 for B type.) Adjust VCO L-3 and L-4 for maximum output.

5. *Correlation of front panel display frequency to actual VCO frequency:* -
   Test equipment required: - Frequency counter
   Test point: - VCO output terminal.

   Confirm frequency changes according to switching of front panel selector switches. Switch through from 144.000 to 148.995MHz at which time the VCO output frequency should be 127.1MHz to 132.095MHz (Receiver local oscillator injection frequency.)

6. *Check of PLL Lock stability:* -
   Test equipment required: - Frequency counter
   Test point: - VCO output

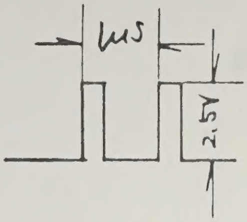
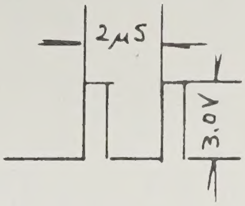
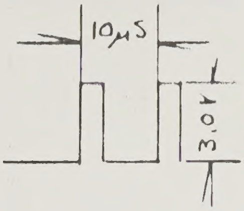
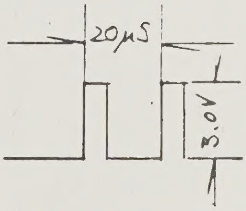
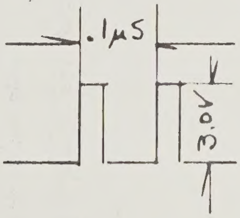
   Switch main power (Pull On Power) switch ON and OFF several times at extreme ends of band. (144.000 and 148.995MHz) Also vary channel switches rapidly and confirm lock-up time appears normal. Also note that frequency display and counter appear to follow channel switching smoothly.

7. *"Unlock indicator":* -
   Test equipment required: - Visual check
   Test point: - Visual check

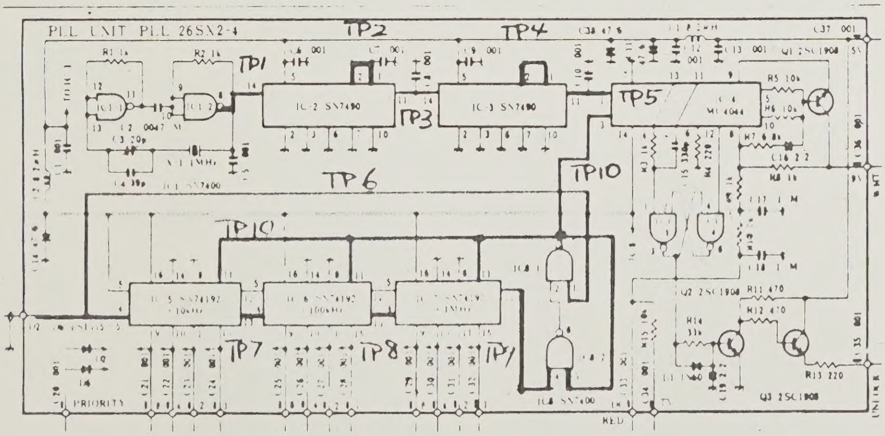
   Switch main power ON and OFF. When power switched ON, LED should light up momentarily and then extinguish immediately. (LED is switched off as soon as PLL lock is acquired.)

8. *Others:* - See notes 2 and 4.

NOTE: 1 **PLL 1MHz OSCILLATOR AND DIVIDER STAGES WAVEFORM AND VOLTAGE**

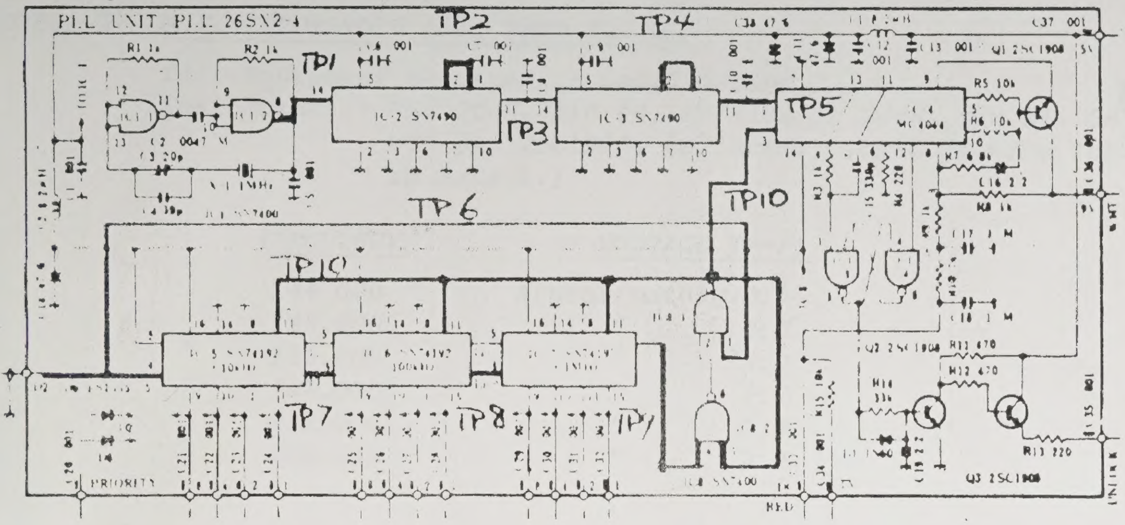
ITEM	TEST POINT	
1,000KHz	Pin #8, IC-1, SN7400 or Pin #14, IC-2, SN7490 (TP-1)	
500KHz	Pin #1 & 12, IC-2, SN7490 (TP-2)	
100KHz	Pin #4 & 11, IC-2, SN7490 or Pin #14, IC-3, SN7490 (TP-3)	
50KHz	Pin #1 & 12, IC-3, SN7490 (TP-4)	
10KHz	Pin #4 & 11, IC-3, SN7490 or Pin #1, IC-4, MC4044 (TP-5)	

TEST EQUIPMENT REQUIRED: **OSCILLOSCOPE**



TEST EQUIPMENT REQUIRED: *OSCILLOSCOPE*

Blown up



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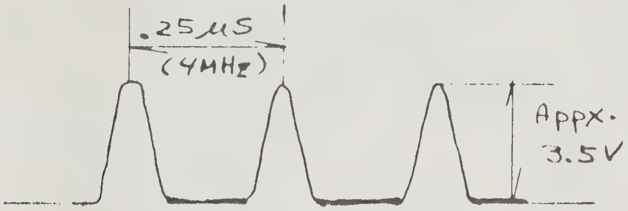
NOTE: 2 R.F. INPUT TO P.L.L. FROM V.C.O.

Test Equipment Required: - Oscilloscope
Test Point: - PLL IC-5, pin #4, SN74192 or IC-8, pin #1, SN7400 or VCO Q6, 23C1908, collector (TP-6 drawing included in Note 1.)

FREQUENCY	VOLTAGE (P-P)
144.000	Approximately 3.5
145.000	" 3.3
146.000	" 3.0
147.000	" 2.7
148.000	" 2.4
148.995	" 2.2

Approximate waveform at 144.000MHz



NOTE: 3 V.C.O. CONTROL VOLTAGE FROM P.L.L.

Test Equipment Required: - V.T.V.M.
Test Point: - Feedthrough capacitor at VCO or PLL with red lead.

FREQUENCY	VOLTAGE (DC)
144.000	Approximately 2.0
145.000	" 2.4
146.000	" 2.9
147.000	" 3.5
148.000	" 4.1
148.995	" 5.0

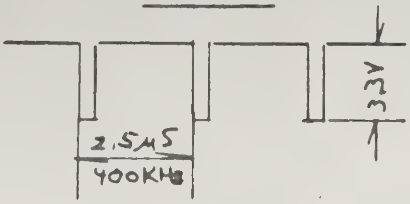
NOTE: 4 WAVEFORM - PROGRAMMABLE COUNTER, P.L.L. (AT 144.000MHz)

Test Equipment Required: Oscilloscope

TEST POINT WAVEFORM

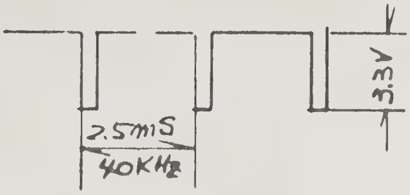
Pin #13, IC-5 (SN74192) or
Pin #4, IC-6 (")

TP-7



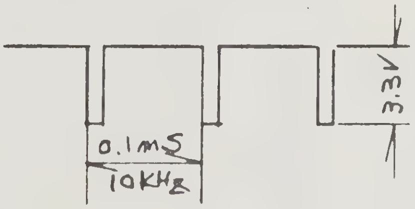
Pin #13, IC-6 (SN74192) or
Pin #4, IC-7 (")

TP-8



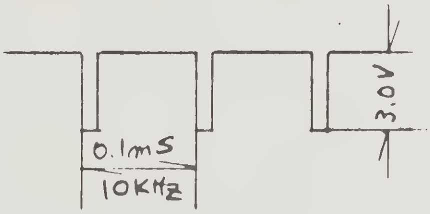
Pin #13, IC-7 (SN74192) or
Pin #4, IC-8 (")

TP-9



Pin #3, IC-4 (MC4044) or
Pin #11, IC-5, 6, 7, (SN74192)
or Pin #3, 5, IC-8 (SN7400)

TP-10



NOTE: For location of TP-7 through TP-10 see drawing at bottom of NOTE: 2.

4. ALIGNMENT OF TRANSMITTER EXCITER MODULE, TX-2SXR2-6

CAUTION: DO NOT KEY EXCITER WITHOUT LOAD: Connect a terminating type RF wattmeter to exciter output for this purpose during entire steps listed below.

1. *Initial adjustment 16.9, 16.3 & 17.5MHz Oscillator:* -
   Test equipment required: - Frequency counter and RF V.T.V.M.
   Test Point: - Emitter of Q2, 2SC1908

   Adjust L2 for maximum RF level at 16.9MHz.
   Adjust C2, C4 and C6 for correct frequencies respectively.
   (Accuracy is not important at this point.)
   See Note: 5 for table of average RF voltages present at each stage of exciter module.

2. *Alignment of amplifier stages:* -
   Test equipment required: - RF VTVM and RF Wattmeter
   Test points: - Collectors of Q3, Q4, Q5 and Q6.

   Set transceiver frequency to center of transmit band, simplex mode.
   (A type 145.000MHz and B type 147.000MHz.)
   Adjust L4 and L5 for maximum RF reading at Q3 collector.
   " L6 and L7 " Q4 "
   " L8 and L9 " Q5 "
   " L10 and L11 " Q6 "

   Observe that output increases smoothly with each suceeding step above.

3. *Alignment of final stage:* -
   Test equipment required: - RF wattmeter
   Test point: - Confirm RF wattmeter connected to exciter module output.

   Adjust C39 and C40 for maximum output.
   Readjust L4 through L11 and C39, C40 to obtain constant output over the 2MHz bandwidth covered by the transmitter. After this adjustment, output should be between 1 watt to 1.5 watts.

4. *Frequency calibration:* -
   Test Equipment required: - Frequency counter and RF Wattmeter.
   Test point: - Connect both to exciter module output.

   Adjust C2, C4 and C6 for proper output frequencies, simplex and duplex Up and Down modes. Note that this adjustment will cancel out any errors caused by 41MHz heterodyning mixer in VCO.

5. *Adjustment of modulation percentage*: -
Test equipment required: - RF wattmeter, Deviation meter and Distortion meter.
Test point: - Connect RF wattmeter and deviation meter to exciter module output and distortion meter to audio output of deviation meter.

Adjust R20 (1kohm trim-pot) for suitable voice level (normally approximately 1/3 way up) and R24 (10Kohm trim-pot) for desired deviation. Distortion should be less than 10% at ±3KHz deviation at 60% modulation of 1,000Hz tone.

5. ALIGNMENT OF TRANSMITTER POWER AMPLIFIER UNIT

1. Connect RF Wattmeter to PA output and transmitter exciter output to PA input.
2. Set all trimmers to respective mid-points and then apply 11V DC to the transceiver. Adjust trimmers C2, C4, C5, C8 and C9 to obtain maximum output.
3. Increase DC supply voltage slightly and repeat step 2 above. Repeat this step until voltage reaches 13.V DC.
4. With 13.5V DC again tweak trimmers to obtain maximum output. At least 12 watts minimum and a maximum of 15 watts should be obtained.
5. Adjust coupling of D1 (1N60) so that Panel meter reads between 7 & 8 during transmit mode.
6. Set HI/LO switch on microphone to "LO" and adjust R3 (10Kohm) on power supply (PP-26SX2-3) to obtain 1 watt reading on RF wattmeter.
7. Vary supply voltage between 11 to 16 volts and confirm output power varies smoothly in accordance with supply voltage. Also confirm does not increase above the 14 or 15 volt level. (Check of overvoltage regulator)
8. Using a spectrum analyzer confirm spurs and harmonics are less than specified value of -60dB.

NOTE: 5 TABLE OF RF VOLTAGES TRANSMITTER EXCITER MODULE

Test equipment required: - RF V.T.V.M.
Test points: - as specified below

Measurements taken with supply voltage 13.5V DC and transceiver set on center frequency (A type 145.000, B type 147.000MHz).

TEST POINT		VOLTAGE	
Q2 (2SC1908)	Emitter	approximately	0.7V
Q3 (2SC1908)	Collector	"	0.6V
Q4 (2SC1908)	"	"	2.3V
Q5 (2SC994)	"	"	5.5V
Q6 (2SC994)	"	"	6.0V
P1 (Input from VCO)		"	0.2V

Above voltages will vary slightly depending on manufacturing lot of transistors, thus as a final check confirm that the exciter module is putting out at least 1watt.

5. ALIGNMENT OF RECEIVER MODULE, RX-2SXR2-4

1. Check Frequency, 2nd Local Oscillator, Q10 - 2SK19

Test equipment required: - Frequency counter
Test Point: - Source of Q10 - 2SK19

Confirm frequency is within ±300Hz of 16.445MHz

2. Check Frequency, V.C.O.

Test equipment required: - Frequency counter
Test point: - Pin number P2, receiver module

Set transceiver to 146.000MHz and confirm frequency of injection voltage from V.C.O. is within reasonable tolerance

3. Check and Adjust Alignment, Discriminator

Test equipment required: - Signal generator, FM
±100uA zero center meter
any convenient size 20KΩ resistor
Test Point: - P10, receiver module. (Connected to hot end of front panel volume control.)

Connect output of signal generator to transceiver input. Set generator to exactly 146.000MHz. Modulate generator with a 1,000Hz tone, 60% modulation, i.e., ±3KHz deviation. Set transceiver to receive 146.000MHz. Connect zero center meter to test point through the 20KΩ resistor. Now tune primary coil of discriminator, L9 (a 162N) to obtain maximum audible output from speaker. This should result in a maximum deflection of the zero center meter. Now adjust the secondary coil, L10, also 162N, so that meter is exactly centered on zero.

4. Alignment of RF, 1st and 2nd IF

Test equipment required: - Signal generator
Test point: - None, use front panel meter

Connect output of signal generator to transceiver input. Set signal generator to 146.000MHz and transceiver to same frequency. Set output of signal generator to obtain at least a mid-scale reading on the front panel "S" meter.

Starting from the RF input coil, L1, adjust tuning slugs to peak reading on "S" meter. Proceed next to interstage coils, L2, L3 and L4. Keep reducing output of signal generator to maintain mid-scale reading on the "S" meter. Go back and re-peak from L1 to obtain maximum reading. Next continue through Lst IF coils L5, L6 and L7, then 2nd IF input coil, L8.

Normally this should be sufficient to achieve required sensitivity, also receiver should not be so far out of tune to require setting signal generator to actual IF frequencies of 16.9MHz and 455KHz.

5. *Touch-up of RF, 1st and 2nd IF*

Test equipment required: - FM signal generator
Distortion meter

Test point: - Connect out of signal generator to transceiver input and input of distortion meter to internal speaker. (For convenience suggest connect to external speaker jack together with suitable 4 ohm

Set signal generator to 146.000MHz. Modulate the signal with a 1,000Hz tone. Set deviation to ±3KHz. Properly null the distortion meter at 1,000Hz. Set output level of the signal generator to obtain at least a mid-scale reading on the distortion meter. Now, readjust the alignment points on the receiver as per step 4. above for the input and RF interstage coils L1 through L4 so that the reading on the distortion meter is reduced. Gradually reduce the output level of the signal generator to keep a workable indication on the distortion meter. This step should normally result in a 3 to 6DB improvement in sensitivity.

6. *Calibration of Front Panel "S" Meter*

Test equipment required: - Signal generator

Test point: - None involved

Signal generator should be connected to transceiver input as per previous steps. Set output of the generator to +20dB. (0dB = 1uV) Check "S" meter reading and if not at approximately 8 adjust trim-pot R23 so meter reads exactly at 8.

7. *Sensitivity and Squelch Sensitivity Checks*

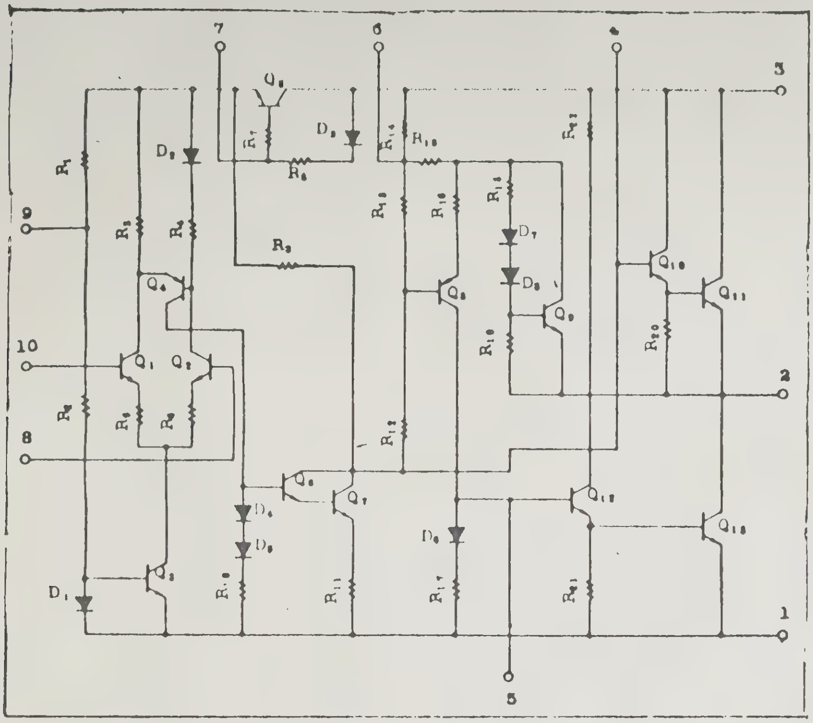
Test equipment required: - Signal generator
VTVM

Signal generator should be connected to transceiver input as per previous steps. Set output of generator to -6dB (.5uV), unmodulated. Connect V.T.V.M. to pin 8 of receiver module. Turn signal generator output on and off and confirm difference in ac voltage reading at pin 8 is better than 20dB.

Reduce output of signal generator and confirm squelch opens with less than a -10dB (.3uV) input.

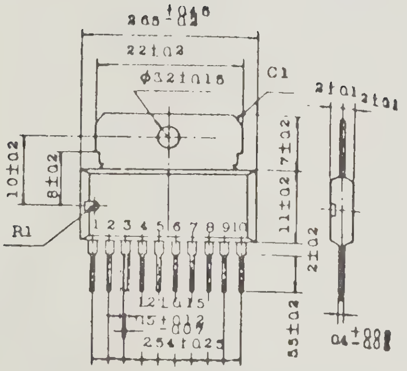
NOTE: 6   EQUIVALENT CIRCUIT OF IC-1, TA7204P AND PIN VOLTAGES

(Audio output IC, Receiver Module)



PIN NO.	VOLTAGE
1	0 (Gnd)
2	6.0 volts
3	12.0
4	7.0
5	1.2
6	10.5
7	12.0
8	5.7
9	5.4
10	5.8

(V.C.C. = 12.0V dc)



CAUTION: When replacing this IC bend fin over prior installing in transceiver. Do not bend exactly at molded case but leave just a fraction unbent, overwise case will be cracked resulting in IC failure.

oriented in power socket BEFORE Applying power to transceiver.

In some instances, power plug (because of manufacturing tolerances) may rotate past protective indent and thus reverse power connections.

ADDENDUM 1 TO INSTRUCTION BOOK

FOR

FM144-10SXRII

Page 1	(Paragraph F) should read "A 15 pole ceramic filter is used in the 2nd IF" . . . .
Page 2	(Paragraph H) should read "High Transmitter output of 15 watts (nominal) and low" . . . . "to a maximum of 15 watts."
Page 6	3(B)(b) 8 ohm speaker
Page 8	(Paragraph C) should read "Power output of 15 watts (nominal."
Page 10	(Paragraph D) should read "is a 15 pole ceramic (E) filter." Other bandwidth . . . .
Page 11	(F) "Any level from 0 to maximum by" . . . .
Page 12	Topview C1 should be C2 " " R20 & R24 interchanged " " Delete arrow left side (Mic gain) " " Add Dev and arrow to R24
Page 16	Transmitter "output": 15 watts (nominal) (13.5V) Receiver "sensitivity": -6dB (0.25uV) or better for 20dB . . . . Audio Output: 8 ohm load Frequency Coverage: "Transmit" 144-147.995MHz 5KHz steps (800 channels)

AWE/1976

When this connector is not in use, pins 1 and 4 must be jumpered with a "U" link to connect receiver audio output to the internal speaker. This connector may be used for the connection of a tone-burst, touch-tone, phone-patch and other similar devices.

(F) ADJUSTMENT OF TRANSMITTER "LO" POWER

Transmitter low power may be set at any level from 0 to 10 watts by adjusting trim-pot VR R-3 located in the power supply unit. This adjustment can be made through the hole on the speaker baffle as illustrated in the COMPONENTS AND ADJUSTMENT LOCATION chart on page 12.

(G) CHANGING PRIORITY FREQUENCY

The priority frequency may be reprogrammed to any desired frequency within the frequency range of the transmitter, and, in increments of 10KHz by rewiring the diode mattrix formed by diodes D-2 through D-6 located in the PLL unit. These can be seen by removing the PLL unit cover and are all connected to the feed-thru capacitor to which a white/green wire is connected.

The diodes should be reconnected from this feed-thru capacitor to the 10KHz, 100KHz and 1MHz terminals in accordance with the table below and will provide any frequency in 10KHz increments within the transmitter frequency range. (Attempting to operate the transmitter over a range wider than 2MHz is not recommended, as power output will be reduced and spurious emmissions increased due to de-tuning of the transmitter amplifier stages.)

CODE freq.	A(1)	B(2)	C(4)	D(8)
0				
1	○			
2		○		
3	○	○		
4			○	
5	○		○	
6		○	○	
7	○	○	○	
8				○
9	○			○

BCD CODE

×10kHz order
A BROWN
B RED
C ORANGE
D YELOW
×100kHz order
A GREEN
B BLUE
C VIOLET
D GRAY
×1MHz order
A WHITE
B WHITE-BLACK
C WHITE-BROWN
D WHITE-RED

WIRE COLOR CODE

SOLID STATE

DIGITAL PHASE LOCKED SYNTHESIZER

VHF FM TRANSCEIVER

MODEL FM144-10SXRII

OPERATOR'S INSTRUCTIONS

KYOKUTO DENSHI CO.,LTD.
21-25, 6-CHOME, HONCHO, NAKANO-KU, TOKYO ·PHONE: TOKYO (382) 2681

CAUTION

READ THIS MANUAL COMPLETELY BEFORE ATTEMPTING TO OPERATE TRANSCEIVER

DO NOT OPERATE THE POWER ON/OFF (PULL ON POWER) SWITCH WHILE KEYING THE TRANSMITTER. SWITCHING TRANSIENTS MAY POSSIBLY DAMAGE THE TRANSCEIVER.

DO NOT CHANGE FREQUENCY WHILE KEYING TRANSMITTER. TRANSMITTER MAY SEND OUT SIGNAL ON RANDOM OFF-BAND FREQUENCY PRIOR ACQUIRING PLL LOCK UP.

HEAT GENERATION IS QUITE HIGH DUE LARGE NUMBER OF DIGITAL IC'S USED. OPERATE WITH TRANSCEIVER IN AS WELL VENTILATED LOCATION AS POSSIBLE.

DO NOT TRANSMIT WITH ANTENNA TERMINAL OPEN OR SHORTED. MODERN TRANSISTORS ARE QUITE RUGGED. HOWEVER, PERMANENT DAMAGE MAY BE CAUSED.

USE A POWER SUPPLY OF AT LEAST 5 AMPERE CAPACITY WITH GOOD REGULATION FOR FIXED STATION OPERATIONS.

OPERATION IN DUPLEX MODE RESULTS IN TRANSMITTER OPERATING 600KHZ HIGHER OR LOWER THAN INDICATED FREQUENCY. THIS MUST BE KEPT IN MIND WHEN OPERATING AT BAND EDGES TO PREVENT POSSIBLE OUT-OF-BAND TRANSMISSIONS.

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MODIFICATION OF 16.445 MHZ SECOND LOCAL OSCILLATOR CIRCUIT

In rare number of cases due to manufacturing tolerances concerning 16.445MHZ Crystal, oscillator may cease oscillating. This modification will assure oscillation at all times.

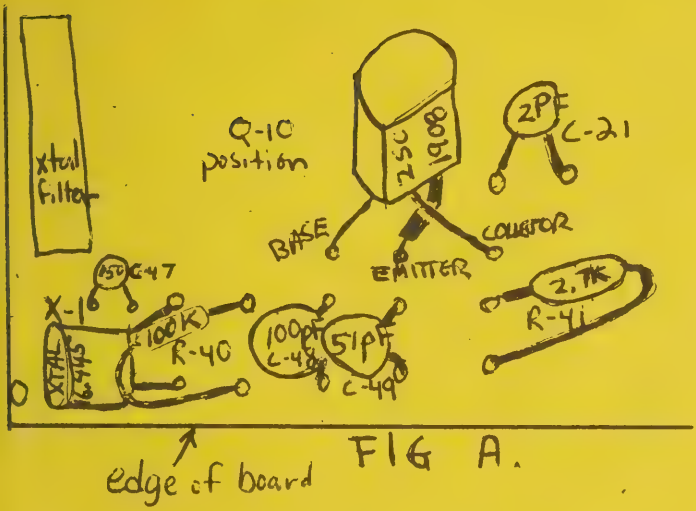
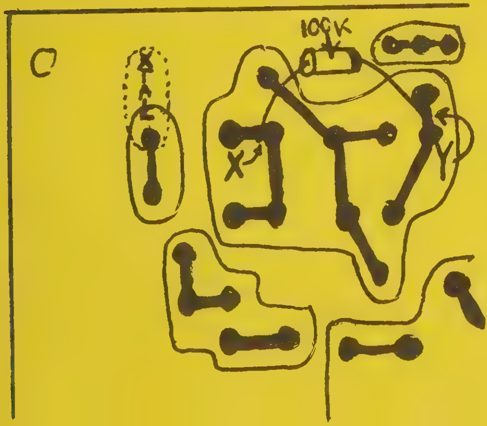


FIG A.

FIG. B (FOIL SIDE)



1. Remove Q10 2SK19BL FET.
2. Replace above with 2SC1908. Note per Figure A that emitter and collector leads will be crossed. Suggest insulate emitter lead with spaghetti.
3. Carefully solder the 100K ohms, 1/8 watt resistor on foil side of printed circuit board between points X and Y (as indicated in Figure B).
4. Replace board. This completes modification.

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WARNING WARNING

Please be certain power plug is correctly oriented in power socket BEFORE Applying power to transceiver.

In some instances, power plug (because of manufacturing tolerances) may rotate past protective indent and thus reverse power connections.

ADDENDUM 1 TO INSTRUCTION BOOK

FOR

FM144-10SXRII

Page 1 (Paragraph F) should read "A 15 pole ceramic filter is used in the 2nd IF" . . . .

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Page 6 3(B)(b) 8 ohm speaker

Page 8 (Paragraph C) should read "Power output of 15 watts (nominal."

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Page 11 (F) "Any level from 0 to maximum by" . . . .

Page 12 Topview C1 should be C2

" " R20 & R24 interchanged
" " Delete arrow left side (Mic gain)
" " Add Dev and arrow to R24

Page 16 Transmitter "output": 15 watts (nominal) (13.5V)

Receiver "sensitivity": -6dB (0.25uV) or better for 20dB . . . .

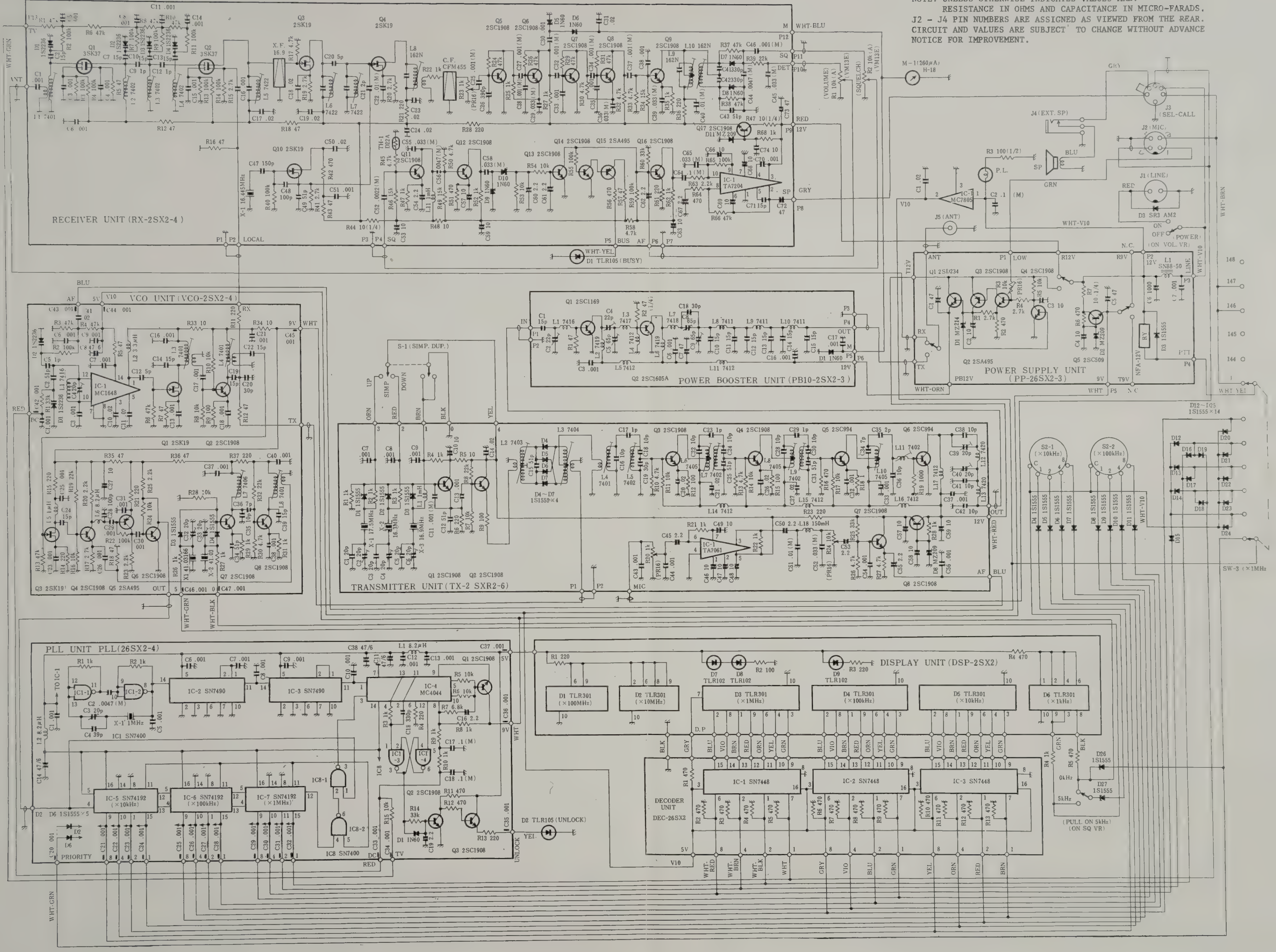
Audio Output: 8 ohm load

Frequency Coverage: "Transmit" 144-147.995MHz 5KHz steps (800 channels)

AWE/1976

FM144-10SXRII CIRCUIT DIAGRAM

NOTE: UNLESS OTHERWISE INDICATED VALUES ARE:
RESISTANCE IN OHMS AND CAPACITANCE IN MICRO-FARADS.
J2 - J4 PIN NUMBERS ARE ASSIGNED AS VIEWED FROM THE REAR.
CIRCUIT AND VALUES ARE SUBJECT TO CHANGE WITHOUT ADVANCE NOTICE FOR IMPROVEMENT.



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10. *CIRCUIT DIAGRAM .... FOLD IN*

1. GENERAL FEATURES

THIS IS A VHF FM TRANSCEIVER FOR MOBILE AND BASE STATION USE WHICH HAS BEEN DESIGNED TO BE "EASY-TO-USE" AND YET MINIATURIZED TO THE MAXIMUM EXTENT POSSIBLE WITHIN THE LIMITS OF PRACTICABILITY CONSISTENT WITH THE MAINTENANCE OF HIGH STANDARDS OF QUALITY, PERFORMANCE AND RELIABILITY.

(A) FREQUENCY COVERAGE AND CHANNELIZATION

Transmit: a) 144.000 - 145.995MHz, 5KHz steps (400 channels), or
b) 146.000 - 147.995MHz, 5KHz steps (400 channels)
Receive: 144.000 - 148.995MHz, 5KHz steps (1,000 channels)

(B) REPEATER OPERATIONS

Simplex and duplex modes of operations are selected by the RPTU-SIMP-RPTD (repeater UP - simplex - repeater DOWN) toggle on the front panel. The UP and DOWN positions automatically shifts the transmitting frequency 600KHz higher or lower than the receiving frequency which remains displayed on the LED's.

(C) DIRECT LED READOUT OF OPERATING FREQUENCY

Six full digits of LED frequency display are provided continuously. This permits closer spacing between digits compared to mechanical methods of display and facilitates accurate reading of frequency at a glance.

(D) FREQUENCY SELECTION

The selector switches for the 100KHz and 10KHz steps require frequent operation. A large and small knob have been arranged coaxially like the knobs of an airliner cockpit control panel. The knobs stop at both ends of travel at positions 0 and 9 making it possible to change frequency by feel only without having to refer to the LED's visually. This permits keeping one's eyes on road conditions at all times while driving.

(E) RECEIVER FRONT END AUTO-TUNING

Varicap diodes are used for tuning circuits of the RF stages. These diodes are controlled by voltages obtained from the PLL providing automatic tuning of these circuits through the wide band of 144.000 - 148.995MHz and thus maintaining full sensitivity at all times.

(F) FILTER CIRCUITS

A combination of a monolithic crystal filter and LC circuits in the 1st IF amplifier provides a superior skirt selectivity characteristic. A 9-pole ceramic filter is used in the 2nd IF to obtain a sharp bandpass characteristic. Provision has been made in the printed circuit board for the installation of a 15-pole filter unit if a still sharper adjacent channel rejection characteristic is desired. (See page 10)

(G) DIRECT FREQUENCY MODULATION OF VCO

A varicap diode is used to apply modulation directly to the voltage controlled oscillator resulting in less distortion than the more conventional reactance phase shift modulators.

(H) HIGH/LOW POWER OUTPUT

High transmitter output of 10 watts and low output of 1 watt can be selected by the switch mounted on the microphone. Thus when communicating with near-by stations the low transmitter power output position may be used to minimize interference to other stations and conserve battery power. Although adjusted at the factory to a normal 1 watt, power output in the low power position can be set by a screwdriver adjustment from a level of 0 to a maximum of 10 watts. This is convenient to use to set low power to approximately 100 milliwatts to use when travelling in company of another car or rag-chewing with an extremely near-by station. (See page 11)

(I) PRIORITY CHANNEL

The first position of the MHz selection switch is labelled "P" and is set up as a priority channel. This is usually set up for the main calling frequency of the country of intended use. This frequency may be reprogrammed by rewiring the diode mattrix located in the PLL module. Any frequency with 10KHz spacing may be selected. (See page 11)

(J) MODULAR CONSTRUCTION

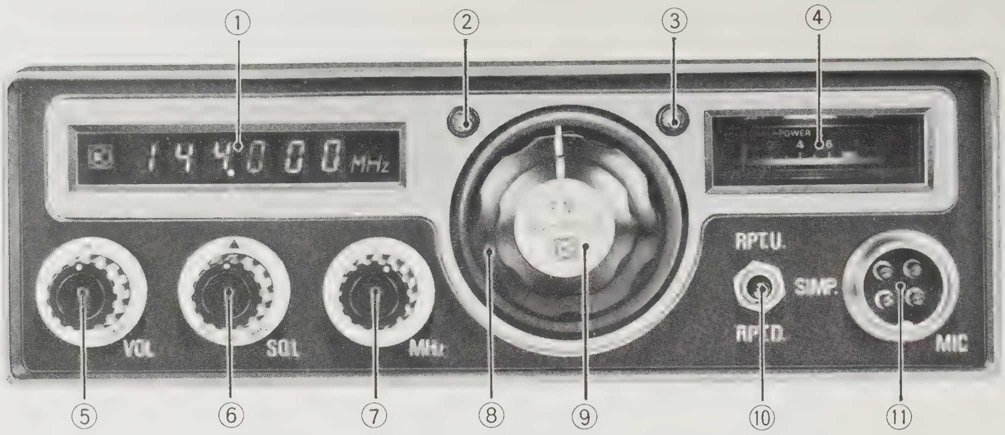
The transceiver is sub-divided into 6 individual printed circuit board assemblies. These are: the receiver, the transmitter exciter, the transmitter booster amplifier, the voltage controlled oscillator, the phase lock loop and the power supply. This modularized construction reduces stray coupling between circuits and thus spurious responses and emissions and serves to improve performance, reliability and ease of servicing.

(K) CONNECTION OF SELECTIVE CALLING UNIT, ETC.

A fully wired outlet is provided on the back panel for connection of a KYOKUTO SC-10 tone encoder/decoder unit. This outlet can also be used for connection of your favorite tone burst, touch-tone or phone patch unit. (See page 5)

2. DESCRIPTION OF OPERATING CONTROLS AND FUNCTIONS

The following paragraphs are numbered to correspond with numbers on illustrations of front and rear panel. (Rear panel view on page 5.)



FRONT PANEL VIEW

(1) FREQUENCY DISPLAY: - Direct digital readout of frequency selected is provided by six bright digits of LED's. During duplex operations, only the receiving frequency is displayed.

(2) CHANNEL BUSY INDICATOR: - During reception of an incoming signal this indicator will light up showing the channel is in use. The light (LED) is activated whenever the squelch is opened and operates regardless of the setting of the volume control. It also functions during a "tone squelch" lock condition when the transceiver is used in conjunction with a KYOKUTO SC-10 selective calling unit.

(3) PLL UNLOCK INDICATOR: - During unlock conditions of the PLL the voltage controlled oscillator may be operating at any random frequency. To prevent keying of the transmitter during unlock conditions, this indicator is provided to light up and warn the operator.

(4) DUAL PURPOSE "S" METER: - This meter provides indications of both receiving and transmitting conditions. During reception, the meter functions as an "S" meter and is set at the factory to indicate approximately 8 with a 20dB (odB = luV) incoming signal. During transmission the meter gives an approximate indication of output power and an output of 10 watts into a 50 ohm load will result in a reading of about 7 or 8. A reading considerably higher or lower than this amount could be an indication of failure of either the antenna or feeder.

(5) VOLUME CONTROL, PULL ON POWER: - Pulling on this knob will apply main power to the transceiver. Turning the knob to the right increases volume and turning it in the opposite direction reduces volume. Pushing the knob in will turn off main power.

(6) SQUELCH CONTROL, PULL ON 5KHZ: - Pulling this knob raises the frequency of operation by 5KHz, pushing the knob back in lowers operating frequency by 5KHz. Setting of the knob can be monitored by reference to the last digit of the LED frequency display. Turning the knob in a clockwise direction will operate the squelch and eliminate receiver noises from being heard from the speaker except when an incoming signal is received.

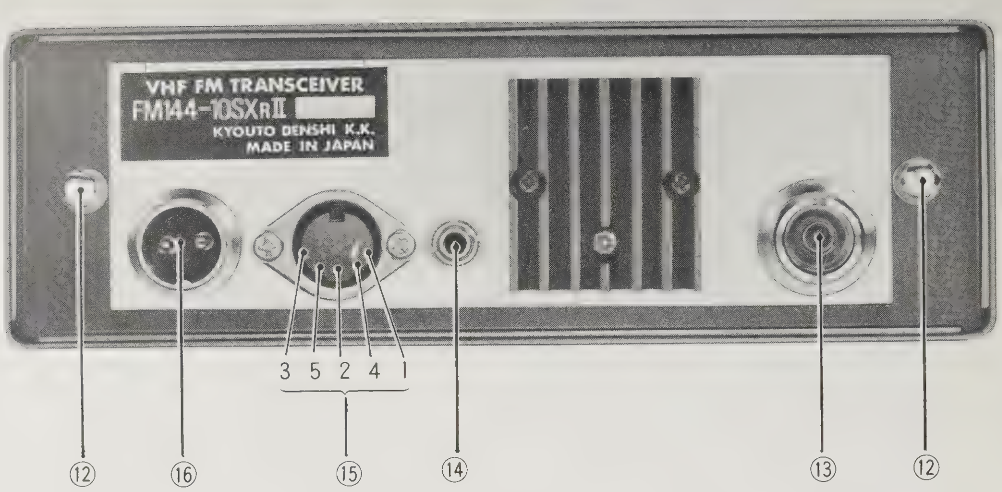
(7) MHZ CONTROL, PRIORITY CHANNEL: - This knob controls the MHz order of operating frequency. The "P" position indicates the priority channel and permits instantaneous selection of a preselected frequency regardless of the position of the other frequency selector knobs. The priority channel of this transceiver is set up on_________MHz. (See page 11 for instructions on how to reprogram if another frequency is desired.)

(8) 100KHZ SELECTOR KNOB: - This knob controls a ten position switch to select operating frequency in 100KHz steps from 00 to 900KHz.

(9) 10KHZ SELECTOR KNOB: - This knob controls a ten position switch to select operating frequency in 10KHz steps from 00 to 90KHz. Both this knob and the 100KHz selector knob rotate through 10 positions and are mechanically stopped at positions 0 and 9 to facilitate frequency changing by feel only.

(10) MODE SELECTOR SWITCH: - This is the simplex/duplex mode selector switch. In the SIMPLEX position the transmitter frequency is the same as the receiver frequency. In the "RPTU" position the transmitter frequency is off-set by +600KHz from the receiver frequency and in the "RPTD" position off-set by -600KHz. (Please note that during duplex operations the LED display shows only the receiver frequency continuously thus caution should be exercised at extreme band edges to avoid making an out-of-band transmission.)

(11) MICROPHONE CONNECTOR: - The microphone provided with the transceiver should be plugged into this connector. Operation of the P/T (press-to-talk) switch on the microphone will key the transmitter. High and low transmitter power is selected by the switch mounted on the microphone. (Microphone provided has an impedance of 600 ohms.)



REAR PANEL VIEW

(12) COVER CAP NUTS: - The outer case can be removed by first unscrewing these two cap-nuts and drawing off the case to the rear.

(13) ANTENNA CONNECTOR: - This is an SO-239 type connector for the antenna feeder. The transmitter is designed to operate into a load of between 50 to 75 ohms, however, mobile antennas tend to be of low impedance and the use of 52 ohm coax is recommended. (The transmitter is adjusted at the factory with a 52 ohm dummy load.) This connector is threaded to accept PL-239 type plugs with both inch and metric threads.

(14) EXTERNAL SPEAKER CONNECTOR: - This is a miniature phone jack type connector for an external speaker. The internal speaker is of necessity quite small and both volume and tone qualities are improved by connection of a larger sized external speaker. The internal speaker is automatically disconnected whenever a plug is inserted in this jack.

(15) SEL-CALL CONNECTOR: - This is a 5 conductor "DIN" standard receptacle for the connection of a KYOKUTO SC-10 tone encoder/decoder unit. When not in use pins 1 and 4 must be shorted using a "U" link as shown in the photograph above. (Jumper is installed ex-factory.) The following connections are available at this receptacle which can be used for connection of a tone-burst, touch-tone or phone-patch unit. (Pin numbers in accordance with "DIN" standard numbering.) #1 - Receiver audio output. #2 - Transmitter modulator input, i.e., microphone. #3 - Transmitter P/T. Apply ground to key transmitter. #4 - Transceiver internal speaker. #5 - +12V DC.

(16) POWER CONNECTOR: - This is a two conductor receptacle for connection of DC power to the transceiver. A power cable including a fuse holder and fuse is included as a standard accessory with the transceiver.

3. INSTALLATION AND OPERATION

(A) MOBILE INSTALLATIONS

a) Mount the metal bracket provided as a standard accessory with the transceiver under the dashboard of the automobile. Secure the transceiver to the bracket using the wing screws provided. The angle of installation is adjustable and should be set for ease of operation.

b) Connect the antenna to the SO-239 type connector on the rear panel. (Item #13, illustration on page 5.)

c) Use the power cord supplied with the transceiver to connect to battery terminals. (Red - positive, black - negative.) If a longer cable is required to reach battery terminals directly a heavier gauge cable should be used to minimize voltage losses. Power source should be 13.5 volts, ±10%. Connection to power source at dashboard of car should be avoided if at all possible to prevent pick-up of alternator whine into receiver and transmitter.

d) Connect microphone provided with transceiver to microphone connector. (Item #11, illustration on page 3.)

e) Confirm fuse is installed in fuse holder in power cable and that a "U" link jumper is installed in "DIN" receptacle. (Item #15, illustration on page 3.)

(B) FIXED STATION INSTALLATION

a) A 13.5 volt 5 ampere DC power source is required. Voltage fluctuation during transmission is an indication of insufficient capacity of the supply. A good reliable and stable supply of sufficient amperage should be used in order to obtain optimum results.

b) A miniature phone plug type connector is provided as a standard accessory with the transceiver for connection of an external speaker. A 4-ohm speaker should be used for best results.

(C) OPERATING INSTRUCTIONS

a) Pull out "PULL ON POWER" knob. (Item #5, page 3.) The panel meter and frequency display LED's will light up immediately.

b) The MHz, 100KHz, 10KHz and "PULL ON 5KHz" knobs should be set to the desired frequency of operation.

c) Turn "SQUELCH" control to full counter clockwise direction.

d) The volume control should be turned gradually in a clockwise direction from the full counter-clockwise position until a steady rushing noise is heard from the speaker.

e) Gradually turn "SQUELCH" control in a clockwise direction until the steady rushing noise is no longer heard. Leave control set at this position.

f) Press the P/T (press-to-talk) switch on the microphone to key transmitter. Select "HI" or "LO" transmitter power using switch mounted on the microphone.

4. CIRCUIT DESCRIPTION

(A) RECEIVER

The incoming signal is fed to the RF amplifier, Q-1, a dual gate MOSFET through the input transformer, L-1 and thence to the LC tuning circuits L-2 through L-4. These tuned circuits are tuned by varicap diodes D-1 through D-4 and keeps receiver sensitivity constant over the entire frequency range covered. The signal is next ned to the 1st mixer, also a dual-gate MOSFET and is converted to the 1st IF of 16.9MHz. Injection to the 1st mixer is provided by the VCO which is described in a later paragraph.

The converted IF signal is passed through a monolithic crystal filter and then to the IF amplifier Q-3, a junction type FET device. The signal next passes through a double tuned LC circuit which cleans up the skirt selectivity of the crystal filter and thence on to the 2nd mixer, Q-4 which is another JFET. The 2nd local oscillator Q-10 is also a JFET for better oscillator stability and clean output waveform and which is crystal controlled at a frequency of 16.445MHz. This output is fed to the gate of Q-4.

The converted signal of 455KHz passes first through a ceramic filter which determines the bandwidth of the receiver and then to the amplifier and limiter circuitry made up of discrete components Q-5 through Q-9. By careful design a stable and low phase shift amplifier has been achieved. After limiting, the signal is detected by the discriminator circuit of D-7 and D-8. A portion of the detected signal is passed through the volume control and amplified by Q-16 and IC-1 and then fed to the speaker. Another portion of the detected signal is passed through the squelch control and then through the noise amplifiers Q-11 Q-12 and is then rectified in a voltage doubler circuit D-10 and D-11. The rectified signal after filtering controls the base voltage of the audio amplifier Q-16 through the switching circuit consisting of Q-13. The busy lamp circuit senses the collector voltage changes of switch Q-13 and after DC amplification by transistors Q-14 and Q-15 controls the LED mounted on the front panel.

The 455KHz signal present at the collector of IF amplifier transistor Q-6 is rectified by diodes D-5 and D-6 in a voltage doubler circuit and is fed to the front panel meter to activate the "S" meter. Trim-pot R-23 adjusts gain of the 2nd IF amplifier and and is used to set the reading of the "S" meter.

Transistor Q-17 is a voltage regulator for the receiver 9-volt supply bus and is controlled by zener diode, D-11.

(B) TRANSMITTER

Diodes D-1 through D-3 select the proper crystal for heterodyne oscillator Q-1 as controlled by the mode toggle S-1. (RPTU - 17.5MHZ, *SIMP - 16.9MHz and RPTD - 16.3MHz.) The signal is fed through buffer stage Q-2 and then to the balanced mixer, diodes D-4 through D-7, where it is mixed with the receiver local injection signal from the VCO. The converted signal (which is now at the final transmitting frequency) is amplified through 6 stages of straight amplification each of which have double tuned LC circuits to achieve approximately 1 watt output at the output terminals.*

Audio from the microphone is amplified by IC-1 and then after limiting, is fed through a 3KHz 12dB/octave LC filter to prevent splatter. The audio is fed to varicap diode D-2 in the VCO unit through an emitter-follower stage, Q-7, in a direct frequency modulator circuit of the VCO itself.

The output from the collector of the final amplifier stage, Q-6, is passed through a double pi-section low pass filter to keep harmonic output and spurious emissions at a minimum.

(C) TRANSMITTER POWER BOOSTER

The 1 watt signal from the transmitter is amplified by Q-1 and Q-2 to achieve a power output of over 10 watts. This unit is completely shielded and contains a three section pi-type low pass filter, with each of the sections shielded from each other by partitions. The thick aluminum base plate doubles as a heat sink and part of the shield around the amplifier unit.

A portion of the output is rectified by diode D-1 and is fed to the front panel meter. Coupling of the diode to the output lead is such that the front panel meter provides an approximate indication of forward power. Meter reading is adjustable by moving the location of the diode with respect to the hot lead through the hole provided in the shielded cover plate.

(D) VOLTAGE CONTROLLED OSCILLATOR (VCO) UNIT

IC-1 and varicap diode D-1 are connected in a oscillator circuit covering 127.1 through 132.09MHz. Output from this circuit is fed through buffer stages Q-1 and Q-2 and then connected to the receiver unit 1st mixer and also to the balanced mixer of the transmitter unit. Output is also fed through the isolation amplifier Q-3 and then heterodyned down to a range of 4.00 - 8.99MHz by mixing in Q-4 with the output of the heterodyne oscillator Q-7. The frequency of oscillation of Q-7 is controlled by either of crystals X-1 (41.03166MHz) or X-2 (41.03MHz) as selected by the "PULL ON 5 KHZ" control. Q-7 is an overtone mode oscillator and the output from buffer stage Q-8 is either 123.09 or 123.0949MHz. The output of mixer, Q-4 is amplified by Q-5 and Q-6, and then sent on to the PLL programmable counter having undergone wave shaping in stage Q-6.

Varicap diode D-2 is included in the VCO circuit module and achieves direct frequency modulation of the VCO by receiving audio from the microphone amplifier and limiter stage in the transmitter unit.

(E) PHASE LOCK LOOP (PLL) UNIT

The 4.00 to 8.99MHz signal from the VCO is entered into the programmable counter made up of IC-5 through IC-7 and is counted. IC-5 counts the 1MHz order, IC-6 the 100KHz order and IC-7 the 10KHz order. The output of the counter is applied to the phase comparator, IC-4 after passing through buffer stage, IC-8.

One half of IC-1 generates the 1MHz frequency standard signal. The decade counters IC-2 and IC-3 divide this signal to 100KHz and 10KHz respectively. The sub-divided signal is then fed to the phase comparator IC-4. IC-4 contains a second phase comparator which is utilized in conjunction with the remaining half of IC-1 used as a N-AND gate to generate an output voltage when in an unlock condition. This output is amplified by DC amplifiers Q-2 and Q-3 and then actuates D-2, an LED mounted on the front panel to give an indication of unlock conditions. A portion of this voltage is also used to control the varicap diodes in the receiver RF circuits.

(F) DECODER/DISPLAY UNIT

This unit obtains the BCD coded output programmed by control switches S-1, S-2 and S-3 which is applied to IC-1, IC-2 and IC-3 to drive the 7-segment LED display units, D-3 D-4 and D-5.

D-3 displays the 1MHz digit, D-4 the 100KHz digit and D-5 the 10KHz digit. The 10MHz and 100MHz digit LED's D-2 and D-1 remain constant. The 1KHz digit D-6 indication is controlled by the "PULL ON 5KHZ" switch on the front panel to indicate either 0 or 5.

(G) POWER SUPPLY UNIT

The DC input from the power connector (13.5v DC) is passed through the noise filter coil L-1, and then fed to regulator Q-5, D-2, to supply the 9-volt supply bus. Power to the power booster unit is controlled by regulator components Q-1 through Q-4 and D-1 so that power supplied to the booster will not exceed 14 volts and constitutes an over-voltage protection circuit. This circuit is also used to lower the booster output to a previously established level by setting of the control VR R-3 for the HI/LO output selection. Power to supply the 5-volt digital TTL circuits is regulated by IC-1 mounted on the rear panel of the main chasis. Reverse polarity protection for the entire transceiver is provided by diode D-3 mounted directly on the input power connector.

5. ADJUSTMENTS AND OTHER APPLICATIONS

(A) RECEIVER METER SENSITIVITY

The "S" meter sensitivity is adjusted at the factory to indicate 8 with an input signal of +20dB (0dB=1uV). This can be changed by adjusting trim-pot VR R-23.

(B) TRANSMITTER MODULATION (DEVIATION)

Transmitter modulation is adjusted at the factory to ±5KHz. This can be adjusted from 0 to a maximum of ±15KHz by varying VR's R-20 and R-24 on the transmitter printed circuit board.

(C) DISCRIMINATOR METER

The difference between the incoming signal frequency and the receiver center frequency can be seen by connection of a ±100uA meter to the detector circuit. This can be accomplished by connecting the meter through a 20KΩ resister to either the hot end of the volume control, VR R-1, or the detector output pin "DET" on the receiver printed circuit board.

(D) CERAMIC FILTERS

The standard filter installed in the transceiver is a 9-pole ceramic filter with a selectivity of ±6KHz, -6dB and ±12KHz, -40dB. Other bandwidth filters are also available as listed below. The receiver printed circuit board pattern has been designed to also accept a higher quality 15-pole ceramic filter with varying characteristics which are also listed herein.

	9-pole filters	*15-pole filters*
(A)	*±17.5KHz -6dB, ±30KHz -50dB*	*±17.5KHz -6dB, ±30KHz -70dB*
(B)	*±15KHz -6dB, ±25KHz -50dB*	*±15KHz -6dB, ±25KHz -70dB*
(C)	*±13KHz -6dB, ±23KHz -50dB*	*±13KHz -6dB, ±23KHz -70dB*
(D)	*±10KHz -6dB, ±20KHz -50dB*	*±10KHz -6dB, ±20KHz -70dB*
(E)	*± 8KHz -6dB, ±16KHz -50dB*	*± 8KHz -6dB, ±15KHz -70dB*
(F)	*± 6KHz -6dB, ±12KHz -50dB*	*± 6KHz -6dB, ±12KHz -70dB*
(G)	*± 4KHz -6dB, ±10KHz -50dB*	*± 4KHz -6dB, ± 8KHz -70dB*

(E) SELECTIVE CALLING, TONE-BURST, TOUCH-TONE AND PHONE PATCH

The connector provided on the rear panel labelled SELCALL is fully wired for the connection of a KYOKUTO SC-10 tone encoder/decoder unit. The following circuits are wired to this connector.

Pin Number	*Function*
1...	*Receiver audio output*
2...	*Transmitter mod. input (Mic.)*
3...	*Transmitter keying*
4...	*Internal speaker*
5...	*12 volts DC, (switched)*

When this connector is not in use, pins 1 and 4 must be jumpered with a "U" link to connect receiver audio output to the internal speaker. This connector may be used for the connection of a tone-burst, touch-tone, phone-patch and other similar devices.

(F) ADJUSTMENT OF TRANSMITTER "LO" POWER

Transmitter low power may be set at any level from 0 to 10 watts by adjusting trim-pot VR R-3 located in the power supply unit. This adjustment can be made through the hole on the speaker baffle as illustrated in the COMPONENTS AND ADJUSTMENT LOCATION chart on page 12.

(G) CHANGING PRIORITY FREQUENCY

The priority frequency may be reprogrammed to any desired frequency within the frequency range of the transmitter, and, in increments of 10KHz by rewiring the diode mattrix formed by diodes D-2 through D-6 located in the PLL unit. These can be seen by removing the PLL unit cover and are all connected to the feed-thru capacitor to which a white/green wire is connected.

The diodes should be reconnected from this feed-thru capacitor to the 10KHz, 100KHz and 1MHz terminals in accordance with the table below and will provide any frequency in 10KHz increments within the transmitter frequency range. (Attempting to operate the transmitter over a range wider than 2MHz is not recommended, as power output will be reduced and spurious emmissions increased due to de-tuning of the transmitter amplifier stages.)

CODE / freq.	A(1)	B(2)	C(4)	D(8)
0				
1	○			
2		○		
3	○	○		
4			○	
5	○		○	
6		○	○	
7	○	○	○	
8				○
9	○			○

BCD CODE

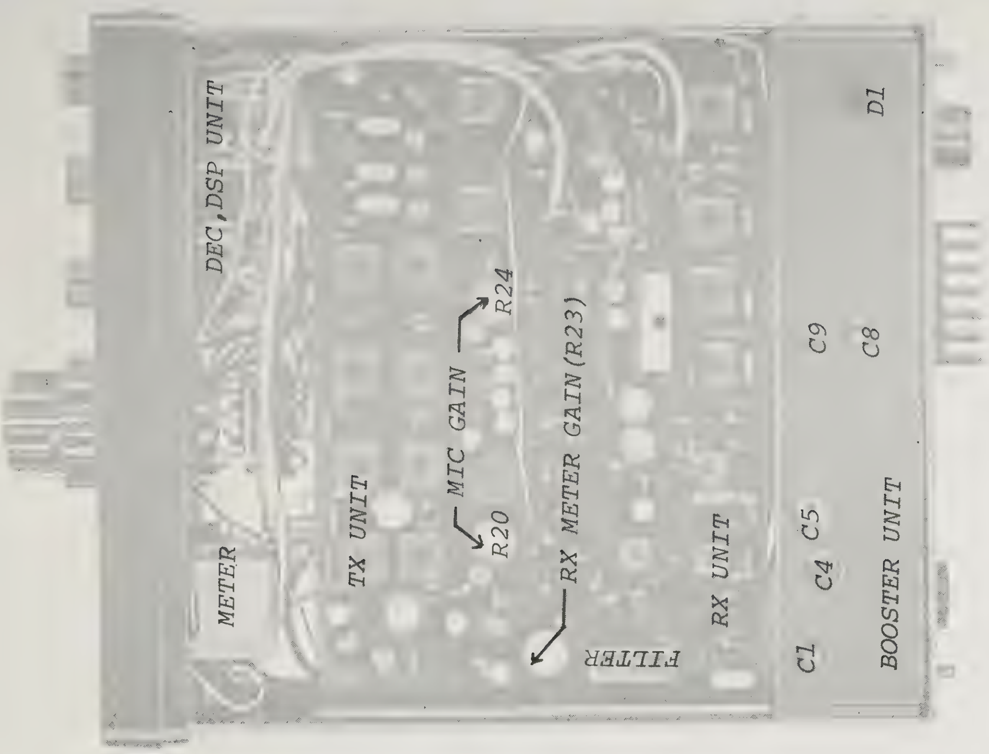
×10kHz order
- A BROWN
- B RED
- C ORANGE
- D YELOW

×100kHz order
- A GREEN
- B BLUE
- C VIOLET
- D GRAY

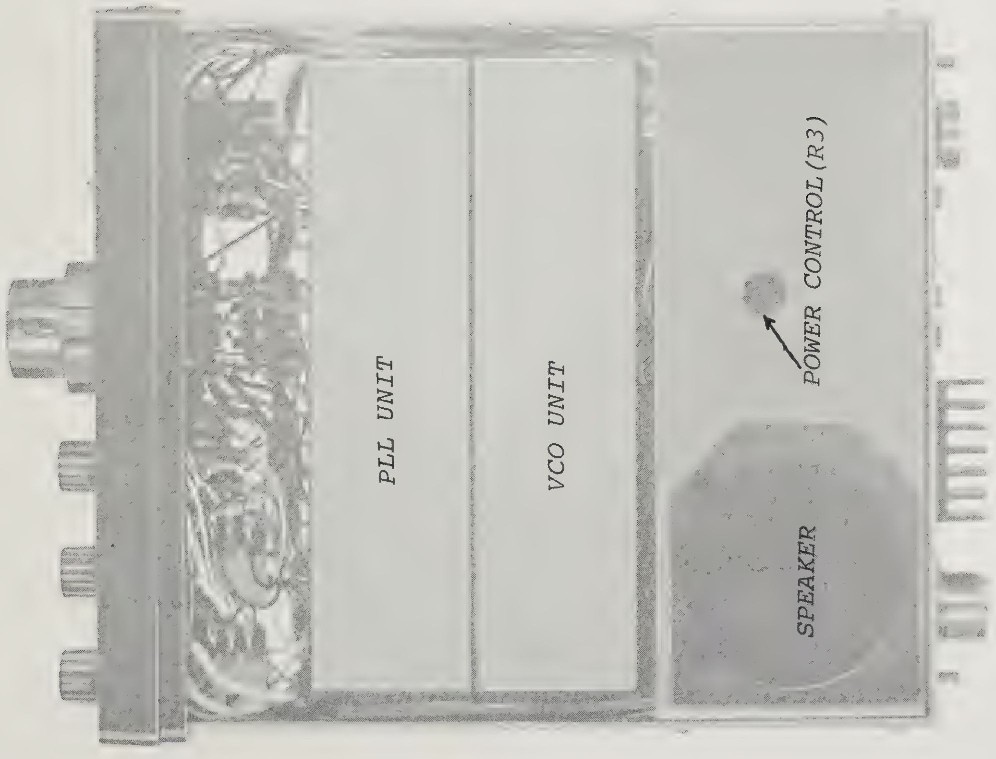
×1MHz order
- A WHITE
- B WHITE-BLACK
- C WHITE-BROWN
- D WHITE-RED

WIRE COLOR CODE

6. INTERNAL VIEW

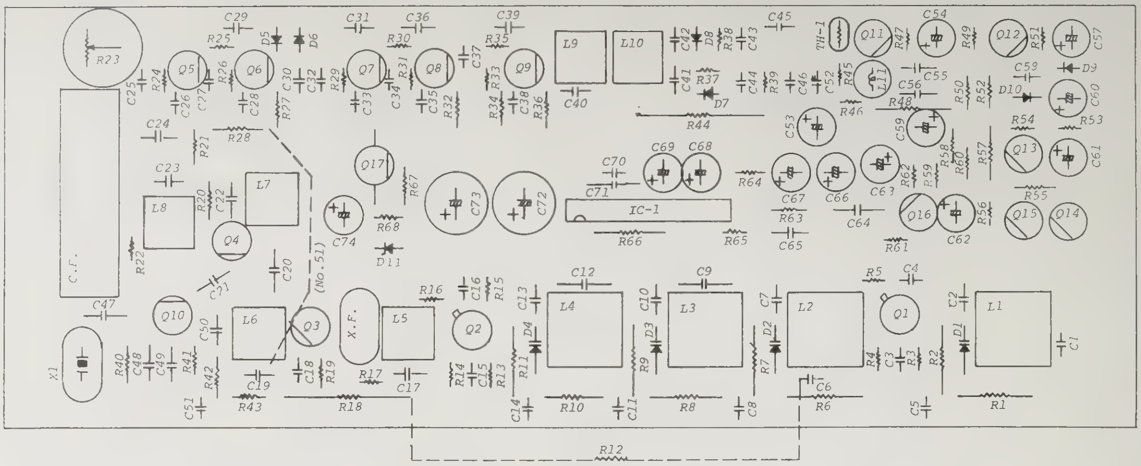


TOP VIEW

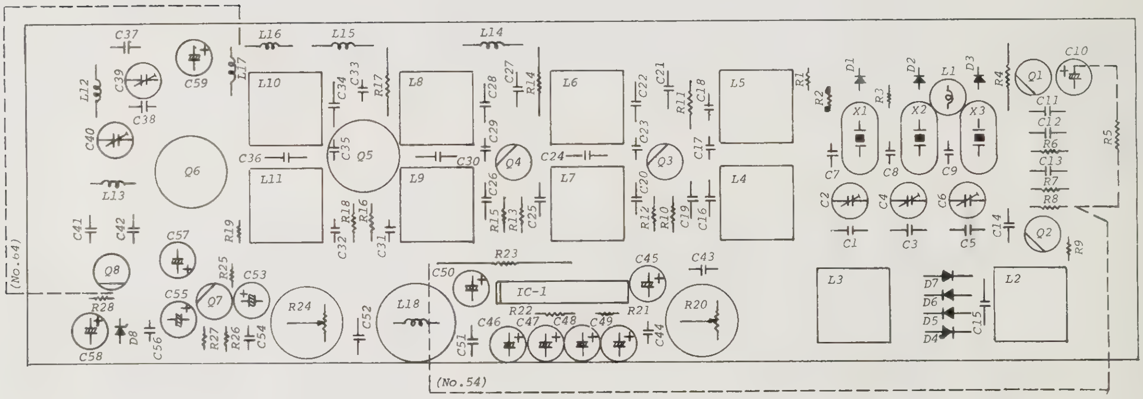


BOTTOM VIEW

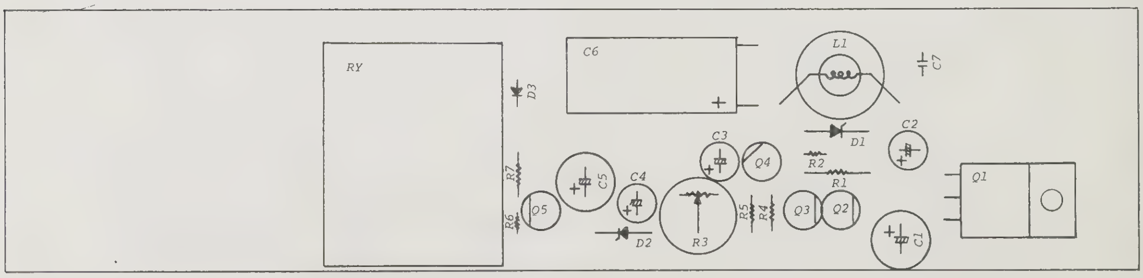
7. COMPONENT LOCATION CHART



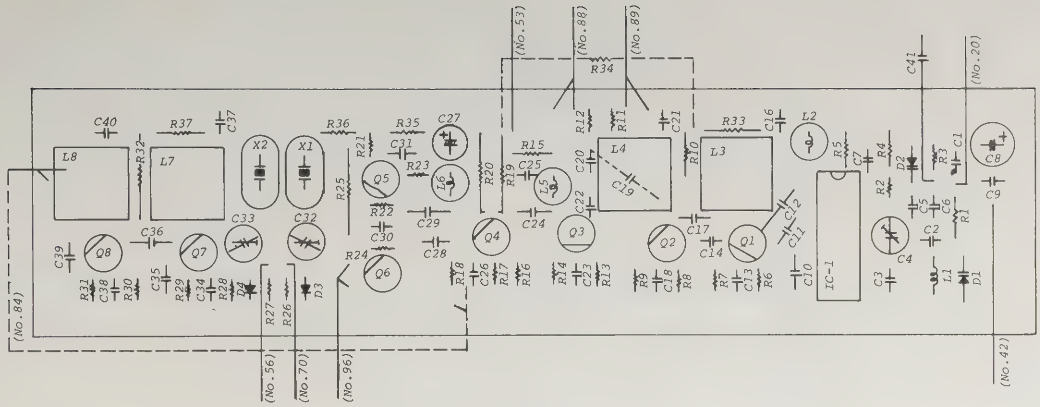
RECEIVER RX-2SX2-4



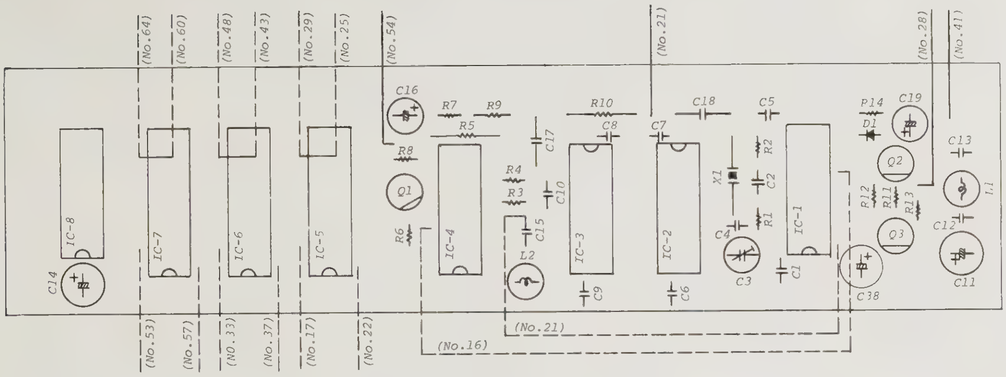
TRANSMITTER TX-2SXR2-6



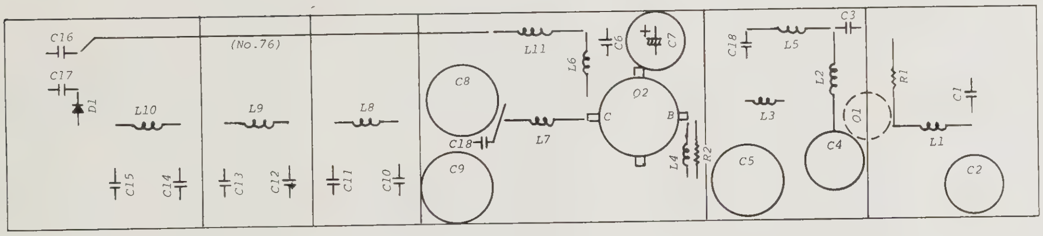
POWER SUPPLY PP-26SX2-3



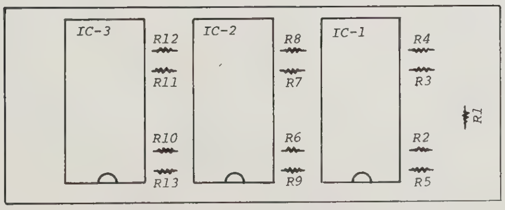
VCO-2SX2-4



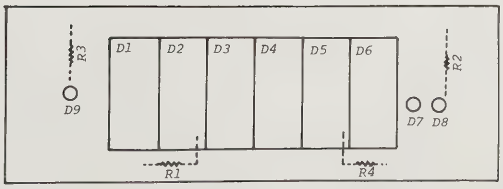
PLL-26SX2-4



POWER BOOSTER PB10-2SX2-3

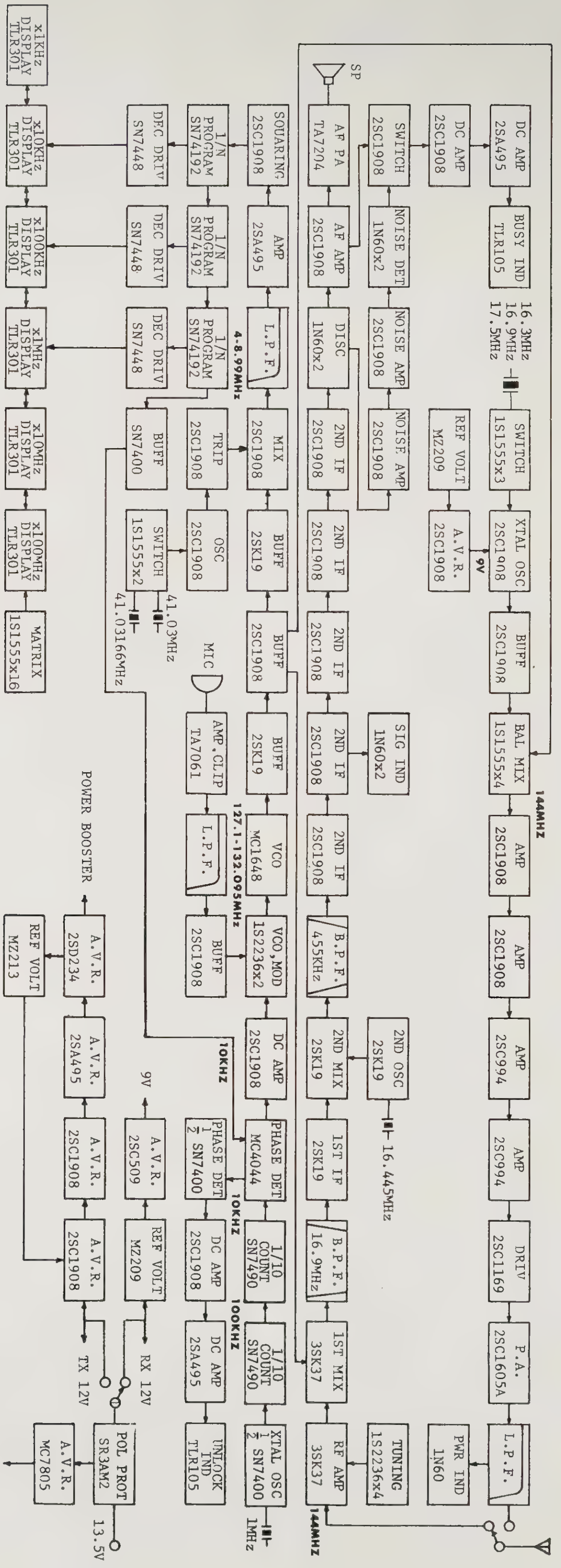


DECODER DEC-26SX2



DISPLAY DSP-26SX2

8. BLOCK DIAGRAM



SPECIFICATIONS

KYOKUTO MODEL FM144-10SXRII

FREQUENCY COVERAGE: Receive......144.000 - 148.995MHz
Transmit..... (a) 144.000 - 145.995MHz, or
(b) 146.000 - 147.995MHz
All above in 5KHz increments.

TYPE OF EMISSION: F-3
ANTENNA IMPEDANCE: 50 ohms, unbalanced feed.
COMMUNICATION MODE: Simplex and Duplex ±600KHz offset.
TEMPERATURE RANGE: 0°C to +50°C
POWER SOURCE: DC 13.5 volts ±10%, negative ground
CURRENT CONSUMPTION: Max 4A transmit, receive .8A standby, max 1A
DIMENSIONS: 2 1/8 x 6 1/2 x 7 1/2 in. (54 x 165 x 195 mm)
NET WEIGHT: 4lbs 10oz, body only (2.1Kgs)
SHIPPING WEIGHT Approximately 6lbs 10oz (3.0Kgs)

TRANSMITTER

OUTPUT: 10 watts or better (13.5V) high power
1 watt low power by switch on microphone
OSCILLATOR CIRCUIT: IC (MC1648) voltage controlled oscillator
FREQUENCY STABILITY: 0.002%
MODULATION SYSTEM: Direct frequency modulation of VCO
VCO FREQUENCY: fvco = fchan +16.9MHz (duplex ±600KHz)
DEVIATION: ±5KHz (adjustable to max ±15KHz)
SPURIOUS RADIATION: Less than 60db below carrier

RECEIVER

RECEIVER CIRCUIT: Double conversion superheterodyne
INTERMEDIATE FREQUENCY: 1st - 16.9MHz, 2nd - 455KHz
FREQUENCY STABILITY: 0.002%
SENSITIVITY: -6dB (0.5uV) for 20dB quieting or better
SQUELCH SENSITIVITY: -10dB (0.3uV) or better
SELECTIVITY: ±6KHz at 6dB down, ±12KHz at 40dB down*
IMAGE REJECTION: Better than 60dB
AUDIO OUTPUT: 4 watts, 4 ohm load, less than 10% distortion

STANDARD ACCESSORIES

DYNAMIC MICROPHONE: 600 ohms, press-to-talk, with "HI-LO" switch
POWER CABLE: With 2 conductor connector and fuse holder, 5A
SPARE FUSE: 5A
EXTERNAL SPEAKER PLUG: Miniature phone plug type
AUTO MOUNTING BRACKET: With mounting screws, nuts and wing-bolts, etc.
INSTRUCTION MANUAL: With circuit diagram, etc.

61220

PRINTED IN JAPAN

SOLID STATE 1000 CHANNEL 5KHz STEP

DIGITAL PHASE LOCKED SYNTHESIZER

2m FM TRANSCEIVER

MODEL:FM-2016A/E

OPERATOR'S INSTRUCTIONS

KDK **KYOKUTO DENSHI CO.,LTD.**
21-25, 6-CHOME, HONCHO, NAKANO-KU, TOKYO PHONE: TOKYO (382) 2681

CAUTION--MEMORY BACK UP BATTERY

The memory back up battery has been installed at the factory. If the transceiver is to be stored without use for an extended period, remove the battery and store in a cool location to prevent possible damage to the transceiver by corrosion.

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1. GENERAL FEATURES

YOUR KDK FM-2016A, (OR E), IS A TWO METER FM TRANSCEIVER USING THE MOST UP TO DATE CMOS IC DIGITAL PLL CIRCUITRY FOR MOBILE AND BASE STATION USE. IT HAS BEEN COMPACTLY DESIGNED WITH EMPHASIS ON MAINTENANCE OF HIGH QUALITY AND YET BEING EASY TO USE AND INCLUDES THE MANY FEATURES DESCRIBED IN THE FOLLOWING.

(A) FREQUENCY COVERAGE AND CHANNELS

144.000 - 148.995MHz, transmit and receive (FM-2016A)
144.000 - 148.995MHz, receive, 144.000 - 145.995MHz transmit (FM-2016E)

Above in 10KHz steps plus 5KHz up capability for a total of 1,000 channels. (FM-2016E - 400 channels, transmit)

(B) DIGITAL FREQUENCY DISPLAY

Direct readout of operating frequencies using large size LED displays. Full solid state.

(C) AIRPLANE TYPE CO-AXIAL FREQUENCY CONTROLS

Operating frequencies selected by 10KHz, 100KHz, 1MHz and 5UP switches. Most frequently used 100KHz and 10KHz switches mounted coaxially on one shaft. These switches will not go below 0 or above 9 positions to facilitate frequency changing by feel only. Permits "eyes-on-the-road" at all times for mobile operation safety and is also useful for hams with impaired sight.

(D) ELECTRONIC MEMORY

An electronic memory using CMOS RAMs (Random access memory ICs) is provided any 4 out of the 1,000 channel capacity may be written in (stored) the memory at any time. A back up NICAD battery provided to retain memory contents while transceiver disconnected from any power source. Current drain only 25nA and internal automatic charging circuit keeps battery fully charged at all times.

(E) TRANSMITTER OFFSET FOR REPEATOR USE

+.6 and -.6MHz positions of the mode switch provide the normal + and - 600KHz shift in the transmitter frequency. Positions 1T-2R and 3T-4R are provided for utilizing the 4 channels of electronic memory to provide 2 pairs of non-standard shifts. In these positions the operating frequency is switched between memory chanels 1-2 and 3-4 automatically so that in position 1T-2R the set transmits on the frequency set up in memory channel 1 and receives on the frequency set up in memory channel 2 and likewise in the 3T-4R position. This feature provides for operating on non-standard shifts, and is also convenient when using the FM-2016 in conjunction with an up-converter, etc., for operation on 430MHz and other bands.

(F) SCANNING

A scanning system has been included to increase the utility of the transceiver. The four memory channels are scanned in one of two possible modes as selected by the SCAN switch. In scanning for a closed channel, the scanner will stop at the first channel in use encountered, and in the open scanning mode, it will stop at the first channel encountered which is not in use. A scan-hold feature is provided to permit immediate transmission after locating a channel by scanning.

(G) RECEIVER SECTION

Dual-gate MOS-FETs are used for the RF amplifier and first mixer and provides a superior inter- and cross-modulation characteristic as well as sensitivity. These characteristics are maintained constant across the wide frequency range covered by the use of an all electronic automatic tuning circuit using varicap diodes in the RF section. The combination of a monolithic crystal in the first IF and a commerical quality 15 pole ceramic filter in the 2nd IF results in extremely sharp selectivity. The 2nd IF amplifier is built up with discrete components rather than using an IC to keep input-output coupling to a minimum. A ceramic discriminator has been adopted for improved temperature stability as well as holding alignment over a long life period. An RIT (receiver incremental tuning control) and discriminator meter is useful when contacting off-frequency stations and an RF attenuator provides approximately 10dB of attenuation when using the transceiver under extreme inter- and cross-modulation situations.

(H) TRANSMITTER SECTION

Single conversion type using a balanced mixer. 5 stages of electronic tuning similar to that of the receiver together with a 4 stage low pass filter in the transmitter output results in a clean, spur-free signal. A latest type silicon transistor is used as the final amplifier and will hold up even under the extreme conditions of an infinite VSWR load. HIGH (15 watts) and LOW (1watt) is available with the front panel power switch, and is useful for reducing power for use in conjunction with a linear. True direct frequency modulation of the VCO results in a very distortion free modulation characteristic.

(I) MULTI-PURPOSE TONE OSCILLATOR

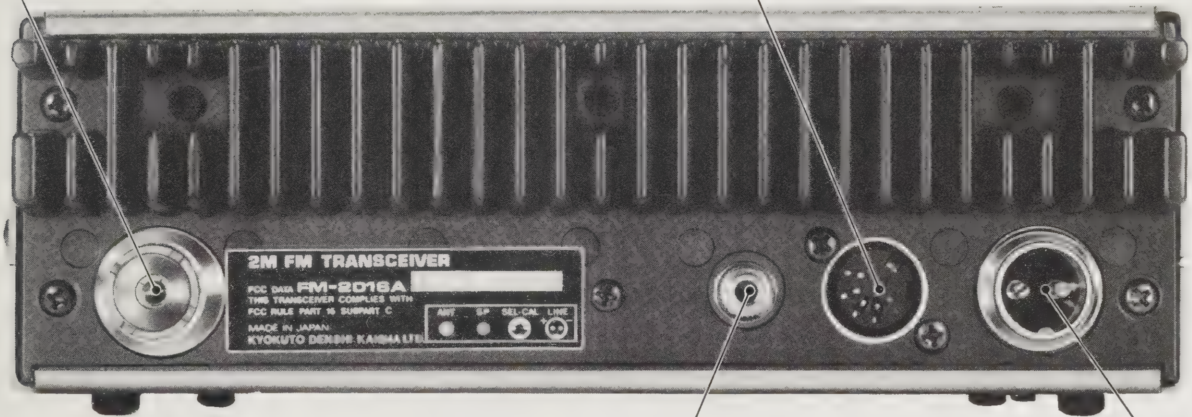
An internal tone generator system has been provided for accessing repeators. Two modes are selected by an internal switch (burst or continuous) and sub-audible or tone burst frequencies can be generated by changing capacitors. (FM-2016A pre-set at factory to 100Hz and FM-2016E pre-set to 1,750Hz.)

(J) ACCESSORY CONNECTOR

A 5 pin "DIN" type connector is provided on the rear panel for connection of a KDK SC-12A SEL-CALL (tone encoder/decoder) unit. Also useful for connection of phone-patch, touch-tone, remote headset-microphone combinations and similar type accessories.

ANTENNA RECEPTACLE SO-239 type coaxial connector for antenna. Will accept both metric and inch threaded plugs.

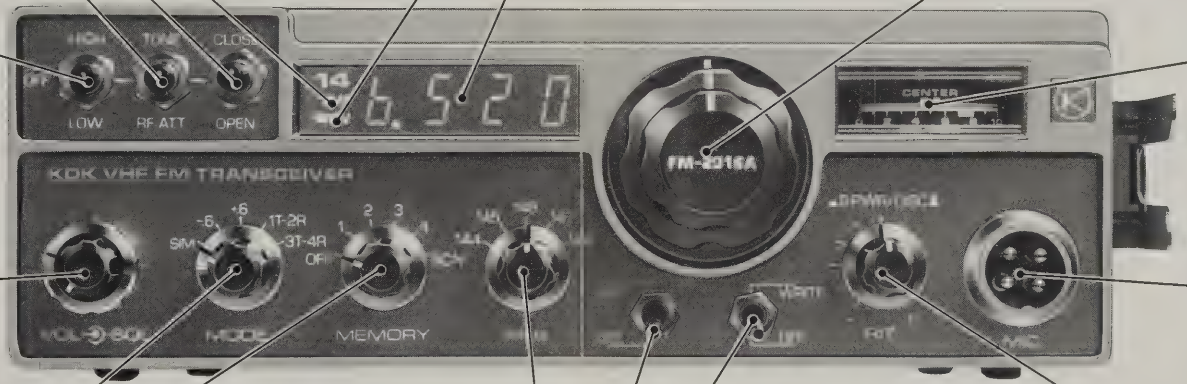
SEL-CALL CONNECTOR For connection of KDK SC-10 or SC-12A, Selcall unit (tone encoder/decoder). Also useful for connection of phone-patch, touch-tone, remote microphone/headset combinations, etc.


2M FM TRANSCEIVER
FCC DATA FM-2016A
THIS TRANSCEIVER COMPLIES WITH
FCC RULE PART 15 SUBPART C
MADE IN JAPAN
KYOKUTO DENSHI KAISHA LTD.
ANT
SP
SEL-CAL
LINE
+
−

EXT SPEAKER JACK For connection of an external speaker for improved reception quality. Impedance 4 - 8 ohms. Miniature phone plug type plug is furnished as a standard accessory.

POWER CONNECTOR For connection of power supply using power cable furnished as standard accessory. Voltage supplied should be 13.8v dc, ±10%, with negative ground. Transceiver equipped with reverse polarity protection. *IMPORTANT: USE ONLY 5A FUSES!*

2. OPERATING CONTROLS AND FUNCTIONS



TONE/RF ATT SWITCH Center position OFF. Switching to WRITE position "stores" frequency set up by the MHz, 100KHz, 10KHz and 5UP switches in memory channells. ATT position reduces receiver sensitivity by approximately 10dBs.

POWER SWITCH Center position OFF. Up position turns on main power to transceiver and also selects HIGH power output of 15 watts. Down position turns on main power and selects LOW power of 1 watt.

SQUELCH/VOLUME CONTROL Squelch control mutes receiver when no signal being received. Turning in clock-wise direction increases depth of threshold.

Volume control increases volume when turned in a clock-wise direction.

MODE SWITCH SIMP position for simplex (transmit and receive on same frequency) operations. +.6 and -.6 positions for standard 600KHz up and down transmitter offsets.

NOTE: DISPLAY WILL SHOW ONLY RECEIVE FREQUENCIES IN THE +.6 AND -.6 POSITIONS.

1T-2R and 3T-4R positions for non-standard offsets using 4 memory channels. 1T-2R uses memory channel 1 for transmit and 2 for receive frequency. Set MODE siwtch on SIMP for writing in frequencies in respective memory channels then switch to 1T-2R or 3T-4R position as desired.

SCAN SWITCH Center position OFF (Hold). In CLOSE position, scanning will stop at first memory channel with an incoming signal. Sensing of channel condition utilizes squelch signal. OPEN position for locating vacant channel.

XMT LED Indicates when transmitter is operating. LED is actuated by P/T relay.

MHz SWITCH Controls MHz digit of operating frequency.

MEMORY SCAN SWITCH OFF position puts 10KHz, 100KHz, MHz and 5UP switch in control of frequency. Positions 1 through 4 select memory channels 1 through 4 and display contents of memory channel on DISPLAY LED's.

SCAN postion for scanning of frequencies stored in memory channels. Frequencies will be displayed as they are scanned.

RCV LED Indicates when a signal is being received. LED is actuated by squelch signal.

FREQUENCY DISPLAY 4 digits of large LED's display frequency selected by the MHz, 100KHz, 10KHz and 5UP controls. Also displays frequencies written (stored) in memory channels when MEMORY switch in positions 1 - 4.

WRITE SWITCH Switching to WRITE position with memory channels 1 - 4 will write in the frequency selected by the frequency controls in whatever memory channel selected by the MEMORY/SCAN switch.

NOTE: Operation of this switch with memory switch in OFF position will still result in the frequency set up by the panel controls to be written in to memory channel 4. This feature can be used to advantage for making a quick QSY.

5UP SWITCH Switch to control 1KHz digit. OFF for 0KHz and 5UP for 5KHz.

10KHz/100KHz CONTROLS Large knob controls 100KHz digit, and small knob controls 10KHz digit. Knobs will not go below 0 or above 9 to permit frequency changing by feel only for driving safety during mobile operations.

THREE-IN-ONE METER Controlled by switch mounted on RIT control. In normal RIT knob pushed in position, meter reads relative incoming signal strength for receive, and transmitter output during transmission.

When RIT knob pulled out, meter functions as discriminator meter.

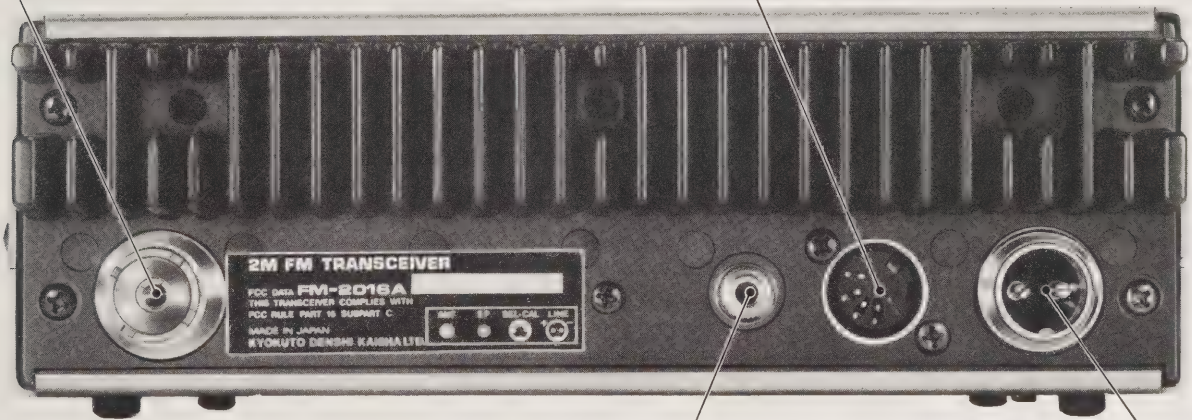
MICROPHONE CONNECTOR Four pronged receptacle for connection of microphone.

RIT/DISC CONTROL Click-stopped at center for center frequency. Moving to + and - varies receiver frequency + and - approximately 5KHz.

Pulling knob out switches meter to give discriminator readings. Full deflection of meter + or - indicates received signal 5KHz above or below correct frequency.

ANTENNA RECEPTACLE SO-239 type coaxial connector for antenna. Will accept both metric and inch threaded plugs.

SEL-CALL CONNECTOR For connection of KDK SC-10 or SC-12A, Selcall unit (tone encoder/decoder). Also useful for connection of phone-patch, touch-tone, remote microphone/headset combinations, etc.


2M FM TRANSCEIVER
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THIS TRANSCEIVER COMPLIES WITH
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LINE

EXT SPEAKER JACK For connection of an external speaker for improved reception quality. Impedance 4 - 8 ohms. Miniature phone plug type plug is furnished as a standard accessory.

POWER CONNECTOR For connection of power supply using power cable furnished as standard accessory. Voltage supplied should be 13.8v dc, ±10%, with negative ground. Transceiver equipped with reverse polarity protection. *IMPORTANT: USE ONLY 5A FUSES!*

3. INSTALLATION AND OPERATING INSTRUCTIONS

(A) MOBILE INSTALLATION

1. Install mobile mounting bracket furnished with transceiver to any convenient under-dash or other location using self-tapping sheet metal screws (4 x 12mm) and washers provided. 3mm holes should be pre-drilled for the 4mm self tapping screws.

2. The transceiver should be secured to the bracket using the 2 winged screws provided. The bracket is designed so the transceiver can be slid forward or backwards in the grooves as well as varying the angle.

3. Connect antenna coax to the connector on the rear panel.

4. Connect power cable to power source. Red lead (+) and black lead (-). The cable should be connected to power at a low impedance point, preferably directly to the battery terminals or the main fuse block, otherwise extraneous noises may-be induced during transmission at high power.

5. Connect microphone to receptacle on lower right corner of front panel.

(B) HOME STATION USE

1. Small rubber feet have been provided on the transceiver to lift its bottom off the surface below and permit audio from the speaker to be heard. However, for easier access to the controls it is frequently helpful to tilt the control panel facing slightly upwards. A mobile mounting bracket used underneath the transceiver is useful for this and brackets are available optionally from your KDK dealor.

2. Connect antenna coax to the connector on the rear panel.

3. Connect power cable to a suitable supply such as a regulated power supply or battery. A good solid supply of 5A or more capacity is recommended.

4. Connect microphone to receptacle on lower right corner of front panel.

(C) OPERATING INSTRUCTIONS

1. PREPARATION: -- Set switches and controls as follows:

a)	POWER SWITCH	LOW or HIGH as desired
b)	RF ATT switch	OFF
c)	SCAN mode switch	OFF
d)	VOLume control	Approximate center position
e)	SQuelch control	Complete counter-clockwise position
f)	MODE switch	SIMP
g)	MEMORY switch	OFF
h)	MHz switch	Desired frequency
i)	100KHz switch	" "
j)	10KHz switch	" "
k)	5UP switch	" "
l)	WRITE switch	OFF
m)	RIT	Center, click-stopped position
n)	S.PWR/DISC switch	S.PWR position (pushed in)

2. RECEIVING: -- During the above preparation the meter lamp will light up, the frequency display LEDs and the RCV LED will be lit up and either random receiver noises or an incoming signal will be heard from the loudspeaker.

a) If no incoming signal is heard, vary the frequency using the front panel controls and locate an incoming signal. As soon as the signal is received, the meter will deflect upwards and indicate the relative strength of the signal.

b) Squelch: -- During no-signal conditions, the random noises heard from the speaker can be annoying. Turn the SQuelch control in a clock-wise direction until these noises are just extinguished. This sets the squelch threshold and only incoming signals will now be heard from the speaker. Turning the control up further may result in loosing weak signals and intermittent reception of intermediate signals. Heavy squelch can be used to advantage in crowded city locations to squelch out weak inteferring signals.

c) RIT and DISCriminator Meter: -- Reception may be impaired if the incoming signal is off frequency, particularly with weak signals. In such instances pull out the RIT knob to switch the meter to the DISC position and adjust RIT knob to center the needle.

d) Memory WRITE Procedure: -- This transceiver has 1,000 channels, and any 4 may be written in to the memory, such as frequently used frequencies. For example, if it is desired to store the frequency of 146.520MHz in memory channel 1 --

1. Use frequency controls and set up 146.520MHz as read out on the DISPLAY.
2. Set MEMORY switch to 1. (If nothing had been stored in this channel previously, LED display will go black at this point.)
3. Switch WRITE switch to WRITE position and then return to OFF. As soon as switch is set to WRITE position, the LED display will show 146.520MHz indicating that the frequency has been written in to the memory channel.
4. Other sequences of writing in frequencies are equally satisfactory and will not damage the transceiver.
5. NOTE: Inadvertent operation of WRITE switch even with MEMORY switch in OFF position will result in selected frequency being written in to memory channel No. 4. This feature can be used to advantage for temporary storage of frequencies, retaining the other channels for storage of repeatedly used frequencies.

e) Scanning: --

1. Set MEMORY switch to SCN position next to memory channel 4.
2. Operate SCAN switch to CLOSE or OPEN as desired. The receiver will immediately start scanning each memory channel consecutively and the DISPLAY LEDs will show the frequencies in each of the memory channels as they are scanned. If the CLOSE mode was selected, scanning will cease at the first channel found with an incoming signal. As soon as this signal disappears, scanning will resume until another signal is received. In the OPEN mode scanning will cease at the first vacant channel encountered. Use CLOSE mode for continuous monitoring of up to 4 channels, and the OPEN mode for quickly locating a vacant channel.
3. If it is desired to transmit using a channel located by scanning, return the SCAN switch to the center OFF position. Transceiver will stay on the frequency (memory channel) located by scanning until MEMORY switch is moved off the SCN position.

f) RF ATTenuator Switch: -- Switching to the RF ATT position reduces sensitivity of the receiver by approximately 10dB's. This is useful when encountering inter- or cross modulation problems due to an extremely strong signal. This is also useful for squelching out weak interferring signals as well as in plotting a radiation pattern of a directional beam antenna.

3. TRANSMITTING: --

a) Select HIGH power (15 watts) or LOW power (1 watt) as desired.
b) Depress the press-to-talk (P/T) switch on the microphone and talk into the microphone in a normal voice. Recommend that the mike be held approximately 2inches (5 cm) from the mouth. A meter reading of approximately 8 indicates 15 watts power into a 50 ohm load. The XMT LED will light up as soon as the P/T switch is depressed indicating the transceiver is on transmit mode and will go out as soon as the switch is released indicating the transceiver has returned to the receive mode.

c) MODE switch: -- Simplex operations are conducted with the MODE switch in the SIMPlex position (Transmit and receive on same frequency). Select +.6 or -.6 as appropriate for working repeators with standard 600KHz offsets. If a non-standard repeator split is required, store the correct transmit and receive frequencies in the appropriate memory channels in accordance with the steps outlined in d) above and then switch the MODE switch to positions 1T-2R or 3T-4R as desired.

4. ADJUSTMENTS

ALL KDK TRANSCEIVERS HAVE BEEN CAREFULLY ALIGNED AND INSPECTED PRIOR TO SHIPMENT AND WE DO NOT RECOMMEND ATTEMPTING FURTHER ADJUSTMENT WITHOUT THE PROPER TOOLS AND TEST EQUIPMENT. HOWEVER, AGING OF PARTS MAY RESULT IN DRIFTING OF SOME CONTROLS PERIOD OF USE AND THE FOLLOWING DESCRIBED ADJUSTMENTS MAY BE MADE IN THE FIELD. ANY OTHER ALIGNMENT OR TUNE-UP SHOULD NOT BE ATTEMPTED WITHOUT THE PROPER TESTING EQUIPMENT AND WE RECOMMEND RETURN TO THE AUTHORIZED DEALOR OR NATIONAL DISTRIBUTOR.

a) RECEIVE "S" METER SENSITIVITY CONTROL

Adjusted to read full scale with a 20dBm input. Adjust control VR1 of Main unit in clock-wise direction to increase sensitivity.

b) DISC. METER ZERO BALANCE ADJUSTMENT

Adjust by varying control VR6 of Main Unit. Short gate terminal of Q12 to ground.

c) RIT ALIGNMENT

Set control to center click-stop position, pull out on knob and switch meter to DISC position. Apply correct frequency input to antenna receptacle and adjust L9 of Main Unit to center needle on zero. (Apply hot soldering iron tip to proximity of tuning slug of this coil to melt sealing wax on slug. CAUTION: Overheating may damage coil.)

d) MICROPHONE AMPLIFIER GAIN

Adjust using control VR7 of Main Unit. Turning in clock-wise direction increases gain. This control is best left untouched unless a severe change of gain is noted as for instance when changing to a different type microphone. Over increasing will result in constant clipping and distortion of transmitted signal.

e) TRANSMITTER DEVIATION CONTROL

Adjusted for ±5KHz at factory. Turning control VR8 of main unit in a clock-wise direction will increase deviation.

f) TRANSMITTER LOW POWER

Continuously adjustable between 1 watt and maximum power using control VR1 of Main Unit. (Do not set below 1 watt). Clock-wise rotation increases power output.

g) TRANSMITTER HIGH POWER

Continuously adjustable between 1 watt and maximum power using control VR4 of Main Unit. Turning in clock-wise direction increases power. (Do not set below 1 watt.)

h) TRANSMITTER POWER METER

Adjusted at factory to give reading of 8 for a power output of 15 watts into 50ohm dummy load. Setting can be changed by varying control VR2 of Main Unit.

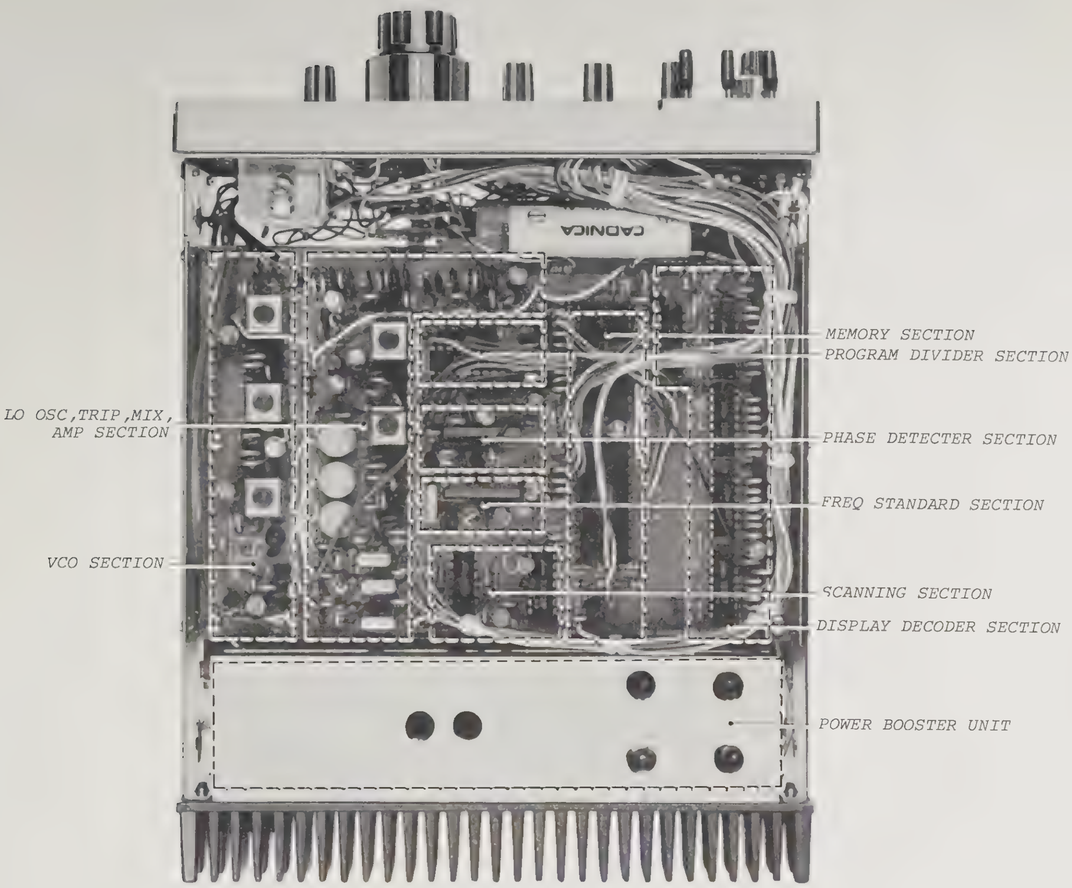
i) MULTI-PURPOSE TONE OSCILLATOR

The tone oscillator is IC-4 located on the main unit. It is designed to provide either a burst or continuous tone as selected by the internal switch. Its frequency can be set by changing capacitors and adjusting the trim-pot according to the following table:

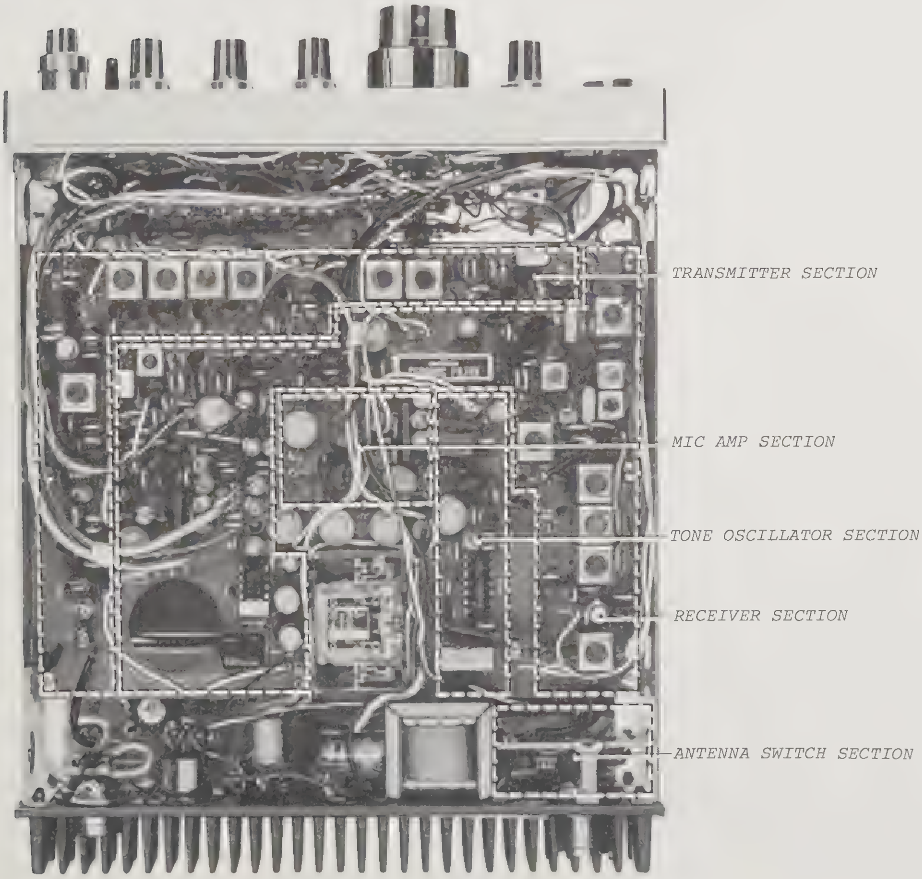
C-124	*C-125*	*Frequency Range*	*Remarks*
.068mfd	*.033mfd*	*Appx. 60 - 130Hz*	*FM-2016A set at 100Hz*
.068 "	*nil*	*" 90 - 210Hz*	*"*
.0047 "	*nil*	*" 1300 - 1800Hz*	*FM-2016E set at 1750Hz*

5. INTERNAL VIEWS

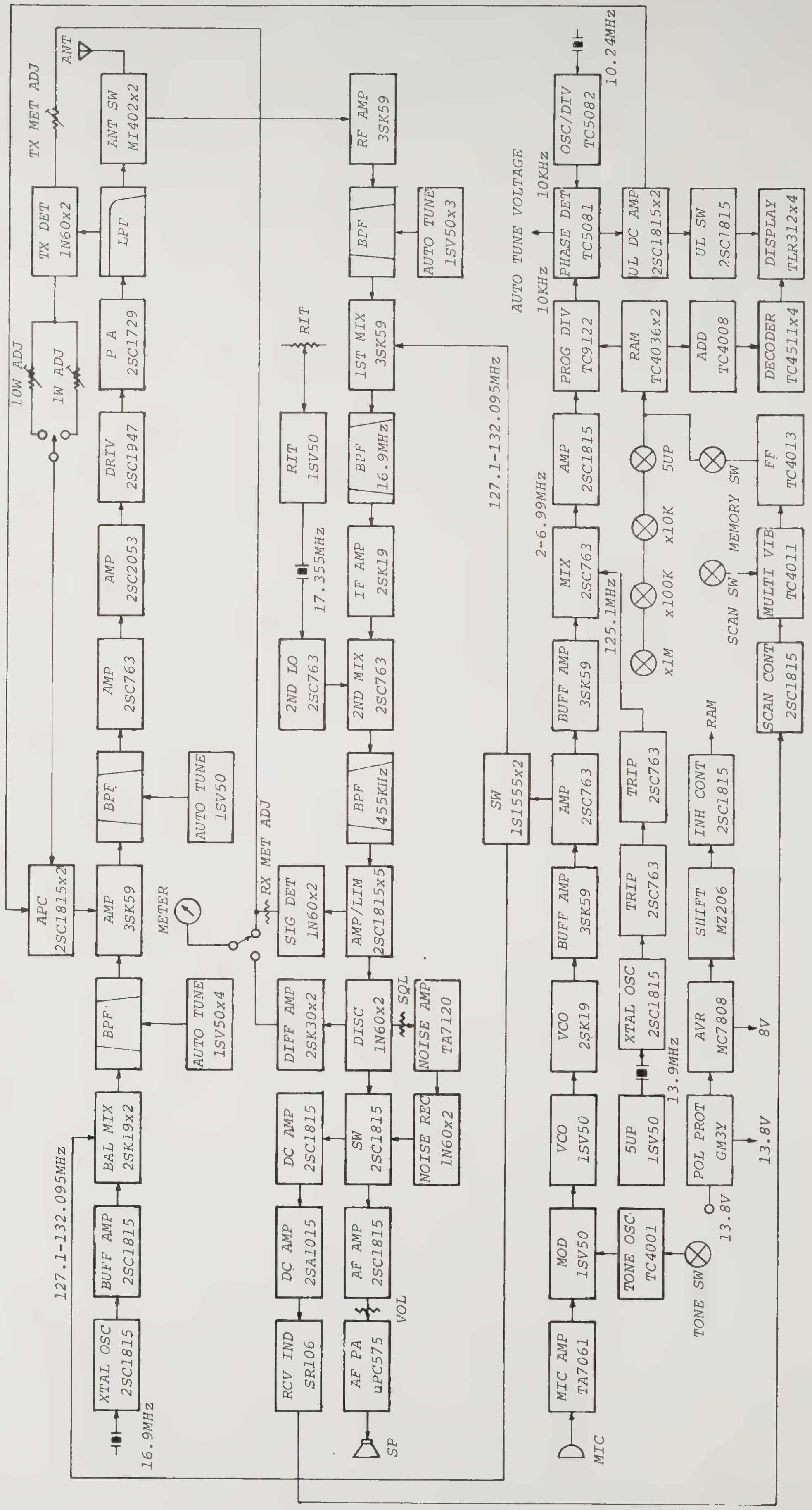
TOP VIEW



BOTTOM VIEW



6. BLOCK DIAGRAM



7. CIRCUIT DESCRIPTION

PLEASE REFER TO BLOCK DIAGRAM ON PAGE 12 AND THE SCHEMATIC WHEN READING THIS SECTION.

(A) GENERAL

The receiver first local oscillator is the VCO controlled by the PLL to provide the correct injection frequency to the mixer. The receiver is of the double conversion superheterodyne type with a 1st IF of 16.9MHz and a 2nd IF of 455KHz.

The transmitter is a single conversion type mixing the output from a 16.9MHz oscillator with the output from the VCO, with modulation being applied directly to the VCO.

(B) MAIN UNIT

This printed circuit board contains the receiver circuits, the transmitter exciter stages, the tone oscillator, the power supply circuits and the APC circuits.

1) Receiver Circuitry: -- Input from the coax receptacle on the rear panel is fed to the input terminal of the receiver through the low pass filter and diode switching circuits on the SW PCB. This signal is amplified by Q1, a dual-gate MOS-FET. The local oscillator signal, (127.1 - 132.095MHz) is applied to gate 2 of Q2, the first mixer, with the output from the RF amplifier being applied to gate 1. The signals are mixed and results in a 16.9MHz 1st IF Signal. This signal passes through the monolithic crystal filter XF with a bandwidth of ±10KHz/3dB, is amplified by a JFET, Q3, and is applied to the base of the 2nd mixer, Q5. The base of Q5 is also fed the 2nd local oscillator signal of 17.355MHz which is generated by Q4. Q5 converts the 1st IF to the second IF of 455KHz. Varicap D4 is in the oscillator circuit of Q4 and a voltage controlled by the RIT control VR is applied to D4 via pin 12. The RIT control varies the oscillator frequency by approximately ±5KHz. The output of mixer Q5 is passed through the 15 pole ceramic filter CF which has a bandwidth of ±8KHz/6dB. Q6, 7, 8, 9 & 10 are the 2nd IF amplifier and limiter stages from which the signal is fed to the ceramic discriminator CD and diodes D10 and 11. Output from the discriminator passes through the de-emphasis circuit R43 and C50, the audio amplifier Q11, and is fed to the volume control via pin 19. The audio returns from the volume control via pin 25 and is then amplified by IC-1, the power amplifier. It is then outputed to the speaker via pin 16.

2) RF Attenuator: -- This circuit functions by lowering the bias voltage on gate 2 of the RF amplifier by operation of the swtich via pin 5 and results in a gain reduction of approximately 10dB's. It is effective in minimizing the effects of interference from strong local signals as well as squelching out weak interference, etc.

3) "S" Meter Circuit: -- The IF signal is picked off the collector of Q7, the 2nd IF amplifier and is rectified in a voltage doubling circuit D5 and D6 and then applied to the meter to give indications of relative signal strength. VR1 adjusts meter sensitivity and normally is set for a 20dBm signal input to give a full scale reading. (Note that meter sensitivity is not linear.)

4) Squelch Circuit: -- Noise present at the discriminator is picked up through the series and parallel tuned circuits C48-L13 and C49-L14 and is then sent to the front panel squelch control through VR5 and pin 17. The signal is returned to the receiver via pin 23 and is then fed to IC-2 for noise amplification. The amplified signal is rectified in a voltage doubler circuit D12 and D13 and is then fed to the base of the squelch switching transistor Q14. During no input conditions to the receiver, receiver noises are rectified, which results in increasing the potential of Q14, connecting the emitter through to the collector. This results in shorting out the base of Q11 and thus grounding both the bias and the signal at this transistor which ceases to amplify and effectively cuts out the receiver noises from being passed to the final amplifier. As soon as an incoming signal is received and the receiver is quieted, the voltage on the base of Q14 drops, the connection between its emitter and collector is broken, normal bias is applied to the base of Q11 and *audio output from the discriminator is amplified and normal reception through the speaker takes place.*

5) RCV LED Circuit: -- The base voltage of audio amplifier Q14 is amplified by two stages of direct coupled transistors, Q13 and Q12, and drives the RCV LED via pin 24. This LED provides an indication when an incoming signal is being received even if the volume control is turned completely off, or when using the transceiver in conjunction with a KDK SC-12A or SC-10 SEL-CALL unit.

6) Discriminator Meter Circuit: -- DC output from the discriminator is amplified by the differential d-c amplifier Q15 and Q16 and is applied to the RIT VR through pins 21 and 22. It then drives the discriminator meter to provide an indication of the incoming signal's frequency. VR6 is the "zero balancer" for the differential amplifier and should be adjusted so that the meter reads zero after first grounding the gate of FET, Q16.

7) Transmitter Circuitry: -- The transmitter is a single conversion, narrow band FM transmitter using direct modulation of the VCO (127.1 - 132.095MHz) which in turn is controlled by the PLL.

8) Microphone Amplifier: -- Audio from the microphone enters the transmitter through pins 8 and 9 and is then fed to the amplifier, IC-3 through the gain control, VR7. C113 and the input impedance of IC-3 combine to provide pre-emphasis. Output from the amplifier/limiter is passed through a 3KHz low pass filter, C120, L27 and C121 to remove harmonics created by clipping and is then fed to the modulator varicap in the VCO circuit via pins 10 and 11.

9) Multi-purpose Tone Oscillator: -- IC-4 and Q27 is the tone oscillator. 2 NOR gates of IC-4 make up a multivibrator. Its oscillating frequency is determined by C124, C125, R104 and VR10. (See values tabulated versus frequency in 4. i). Output from the oscillator is fed via pin 11 to a low pass filter R103, C123 to remove harmonics created by the multivibrator. This filtered output is bufferred by Q27 and then fed to the low pass filter of the microphone amplifier through the level control, VR9.

The circuit can provide either a sub-audible tone or a higher frequency tone burst. It can further be switched to provide either a continuous tone for the duration of the transmission or a short burst at the beginning of each transmission by operation of the internal switch mounted on the Main Unit PCB.

The oscillator is controlled by the voltage applied by the TONE/RF ATT switch through pin 46. For the tone burst, C128, R108 and 2 NOR Gates of IC-4 make up a "one shot multivibrator" with a period of approximately .5 seconds.

The FM-2016A transceivers are set at the factory for a sub-audible tone of 100Hz and the FM-2016E transceivers are set for a 1750Hz tone burst.

10) APC Circuit (Output Control): -- RF power is sampled by the diode D2 in the power booster module and is fed to the d-c amplifier Q24 and Q25 via pin 37. The signal is then applied to the base of a buffer, Q21 and by varying the base voltage controls the output. VR3 sets the low power output and VR4 sets the high power output through the main power switch and pins 14, 15 and 27. The unlock signal from the synthesizer unit is applied to the APC through pin 27.

11) Transmitter Exciter: -- Transistor Q17 and crystal X2 combine to generate a 16.9MHz signal which is amplified by Q18 and is fed to the balanced mixer Q19 and Q20 through tuned circuits L15 and L16. The TX local oscillator signal from the synthesizer unit is also applied to the mixer through pins 6 and 7. (127.1 - 132.095MHz). The mixer converts these inputs to the desired signal frequency (144.0 - 148.995). This output is passed through 4 sucessive stages of electronic tuned circuits, inductors L18, L19, L20, L21 and varicaps D14, D15, D16 and D17 which are peaked at the operating frequency to minimize spurs. This circuit is similar to the circuits employed in the receiver and are effective in attenuating all but the desired frequency. The output is amplified by a dual gate MOS-FET, Q21 and passes through *another auto-tuned circuit, L22 and D18 and is amplified to approximately 0.3 watts by Q22 and Q23. This signal is applied to the power booster module through terminal TX.*

12) Power Booster Module: -- Output from the Main Unit is applied to the booster through pins 1 and 2. It is then amplified by Q1 and Q2 to attain an output of over 15 watts. The output is matched to 50 ohms through step-up coil L6 and matching capacitors VC5 and VC6 and is then fed through a 3 stage low pass filter, L7, L8 and L9 and associated capacitors. Output from the filter is outputed from pin 3 and is applied to the antenna receptacle through the SW Unit. A portion of this output is picked up by diodes D1 and D2 in a voltage doubling circuit and is used to drive the power indicator (meter) and the APC circuit through pin 4 of the booster and pin 27 of the Main Unit. Reading of the power meter is set by VR2 and is connected to the meter through pin 13 of the Main Unit.

13) Antenna Switching (SW) Unit: -- RF power switching diodes D1 and D2 are used in a solid state switching circuit to minimize mis-matching in the antenna changeover circuits. The received signal is fed from the antenna receptacle through the low pass filter L3, C6 and C5 and then to the receiver input of the Main Unit through C4, L2 and C3. During reception, no d-c current flows through D1 and D2 and thus the 2 diodes are in a cut-off condition and D1 prevents the flow of the signal into the transmitter. For transmitting, a control voltage is applied to D1 through L1 and results in a current flow through D1, L2 and D2. D1 conducts to pass the transmitter signal to the low pass filter through C4. L2 also appears in the output circuit of D1 but presents a high impedance to the signal thus the transmitter signal passes through to the low pass filter and the antenna receptacle. Any signal leaking through L2 is grounded as D2 is also conducting and thus does not feed in to the receiver input circuitry.

(C) SYNTHESIZER UNIT

The receiver 1st local oscillator signal and the transmitter local oscillator signal are centrally generated by this unit which consists of the VCO circuit, crystal standard oscillator, the programmable divider, the phase comparator, the unlock detector, the RAMs, the scanning, display and decoder circuits.

1) VCO Circuit: -- The VCO circuit consists of Q1, L2, C3 and D2. The d-c output from the phase comparator, IC-2, is applied to D2 and locks the oscillator frequency. Capacitor C2 and varicap D1 are connected in paralel with the VCO and audio from the microphone amplifier is applied to D1 via pins 1 and 2 to derive direct FM of the VCO. The VCO's output is bufferred by Q2, amplified by Q3 and then applied to the receiver through switching diode D3 via pins 18 and 19. Output to the transmitter is switched by diode D4 and applied to the transmitter through pins 20 and 21.

2) Frequency Conversion and Amplifier Circuits: -- A portion of the output from Q3 is picked up through C22 and bufferred by Q4. It is then applied to the PLL mixer, Q5. A separate PLL local oscillator signal (SIMP = 125.1MHz, -.6 = 124.5 and +.6 = 125.7MHz) is mixed with the output from Q4 and thus converts the signal to the PLL IF of 2.0 - 6.99MHz. The PLL local oscillator signal is derived by Q19 oscillating in the 13.7MHz band, tripling by Q10 and again tripling by Q11. This signal is then applied to the PLL mixer. The frequency of the local oscillator is controlled by X4 = 13.9MHz for the simplex frequency of 125.1MHz, X3 = 13.833MHz for the -600KHz frequency of 124.5MHz and X2 = 13.966MHz for the +600KHz frequency of 125.7MHz, these crystals being switched by diodes D5, D6 and D7. Also diodes D10, D9 and D8 are connected in series with these crystals and raise the PLL local oscillator by 5KHz through operation of the 5UP switch. The 5UP voltages to these varicaps are set by individual controls, VR3, VR2 and VR1 to obtain exactly 5KHz. The 2 to 6.99MHz PLL IF signal is passed through the low pass filter, L6 C31 and C32, and then amplified to achieve sufficent levels to drive the programmable divider, IC-1.

3) Frequency Standard and Divider Chain: -- IC-3 oscillates at 10.24MHz in conjunction with crystal X-1. It is divided by 1/1024 by the pre-scaler contained in IC-3 to achieve a standard signal of 10KHz and then is applied to IC-2, the phase comparator.

4) Programmable Divider: -- The 2 to 6.99MHz PLL IF signal is applied to pin 2, the input to the programmable divider section of IC-1. This divider divides the signal by a factor of 200 to 699 as determined by the program data input H and L levels applied to pins 3 through 13 of the divider. These levels are set up by the front panel MHz, 100KHz and 10KHz switches through the RAM IC's. The IC-1 program input pins 3 through 6 are for the 10KHz digit, 7 through 10 the 100KHz and 11 through 13 the MHz digits respectively and accept H level BCD coded inputs.

5) Phase Comparator: -- IC-2 is the digital phase comparator. The PLL IF signal divided by "N" is applied to 2 and the 10KHz standard is applied to pin 7. IC-2 compares the two signals and outputs a d-c voltage from pin 3 in proportion to the phase difference between the two signals. This d-c voltage is passed through the active low pass filter formed by pins 1 and 2 of the IC and is used as the VCO and receiver electronic tuning circuit control voltages.

6) Unlock Circuit: -- When the PLL circuit is out of lock the VCO is oscillating in an unstable off-frequency condition thus proper transmitting and receiving is not possible. In order to prevent off-band transmissions, etc., circuitry is provided to stop the operation of the transmitter amplification stage. When the PLL is properly locked in, pin 4 of the phase comparator, IC-2, is mainteained constantly at approximately the power supply voltage. Thus Q7 is conducting and its emitter and collector are connected through. Thus, no voltage difference is observed between the emitter and ground of the following d-c amplifier, Q8. When the PLL is out of lock, a downward facing 10KHz pulse appears on pin 4 of IC-2. This pulse switches Q7 on and off. This pulse is smoothed by the combination of R30 and C55 so that the emitter of Q8 rises to approximately the power supply voltage. This voltage created as a result of the PLL going out of lock is applied to the APC circuit of the Main Unit in order to inhibit the transmitter as well as being applied to pin 4 of the decoder IC's to blank out the LED frequency display to advise the operator the PLL is out of lock.

7) Frequency Control and Memory Circuits: -- This transceiver is designed with mobile operations in mind, thus all frequency control operations are possible by operation of front panel controls. Output from these controls are BCD coded. The coaxially mounted 10KHz and 100KHz controls program the RAM IC data input terminals directly. A 5 position switch with diode mattrix is used for the MHz switch and its output is also applied to the RAM IC input terminals. The last digit, single KHz, uses data input pins 7 through 10 of IC-11. 5KHz up is the only combination used. Data input terminals 3 through 6 of IC-11 is for the 10KHz digit and in the same manner, pins 7 through 10 and 3 through 6 of IC-12 is for inputting 100KHz and MHz information. Data information is by H level inputs.

When front panel controls are utilized for direct operations, the memory switch is in its OFF position. The memory switch OFF position applies an H level to the memory by-pass terminals, pins 11 of RAM IC's IC-11 and IC-12. Thus the data input applied to the RAM IC's appear directly at the RAM IC output terminals and thence are inputted to the programmable divider, IC-1. This output is also applied to the decoders in order to drive the LED display units.

For memory operations, pins 1 and 23 are driven by H level binary codes to provide 4 words (4 channels) of memory. Selection is by operation of the memory switch through channels 1 through 4. Output from the switch is converted by means of a diode mattrix to provide the proper binary coded signals to the address terminals, pins 1 and 23. Operation of the memory switch from OFF to the memory channels changes the level at the memory by-pass terminals from H to L, disabling the by-pass function. Operation of the WRITE switch WR applies an H level to pin 2 of the RAM IC's and writes in the information present at the input terminals to the memory cells. Returning the WR switch to its OFF position presents the memorized data to the output terminals.

The memory IC's used in this transceiver are CMOS RAM IC's and memory content will be lost if power is removed from the RAM IC's. A NICAD battery is provided internally to maintain power to the RAM's even when the transceiver is disconnected from any external power source. When power is applied and the main power switch is ON, 8 volts d-c is applied to pin 24 through diode D16. When the power switch is turned OFF, the power through the voltage shift circuit R113 and D17 drops below 6 volts, Q15 conducts and changes the RAM "chip inhibit" terminals 22 from a L level to a H level and reduces the RAM current consumption to 24nA which is sufficient to retain memory content. Also, when the main power switch is turned ON, the NICAD battery is charged through R111 at a rate sufficient to re-charge the battery in a short period.

Output data from the RAM's is applied to the decoders for conversion of the BCD coding to that required to drive the seven segment LED units as follows: -- 1KHz digit to IC-4, 10KHz digit to IC-5, 100KHz digit to IC-6 and the MHz digit to IC-8 through an adder, +2, to IC-7. Voltages to drive the LED's are applied to the LED's through current limiting resistors, R52 - R81. Pin 4 of the decoders are driven to the L level by Q14 when the PLL unlocks and this blanks out all of the LED units except for the decimal point.

8) Scanning Circuitry: -- Scanning is performed by switching each of the RAM IC's address terminals. 2 NOR gates of IC-9 form a multivibrator with its frequency determined by the time constant of R87 and C91. Pulses from this multivibrator drive the flip-flop circuit of IC-10 which in turn drives the address lines of the RAM's. the squelch signal from the receiver is passed through Q12 and then 2 NOR gates of IC-9 to control oscillation of the multivibrator. During scanning, switching transistor Q13 is conducting in order to disable the memory by-pass function.

(D) POWER SUPPLY CIRCUITS:

The full power supply voltage of 13.8 volts is applied to audio output IC, IC-1, the relay and the power booster unit. All other circuits are powered by regulated 8 volts supplied by IC-1 mounted on the inside of the rear panel, either directly, or through P/T relay mounted on the Main Unit.

8. SPECIFICATIONS : MODEL FM-2016A/E

GENERAL

FREQUENCY COVERAGE: 144.000 - 148.995MHz, 10KHz steps & +5KHz, 1000 channels.

144.000 - 148.995MHz, Ditto above receive only, FM-2016E
144.000 - 145.995MHz, Transmit, FM-2016E

SEMI-CONDUCTORS 11 FET, 33 Transistors, 17 IC's and 65 Diodes
MEMORY CHANNELS: 4 Channels
SCANNING: Scanning of 4 memory channels for open and closed channels.
FREQUENCY STABILITY: Better than +.002%
USEABLE TEMPERATURE RANGE: -20°C to +60°C
POWER SOURCE: DC 13.8v, ±10% (negative ground)
ANTENNA IMPEDANCE: 50 ohms nominal, unbalanced
CURRENT CONSUMPTION: Less than .4A receive standby, .6A maxium volume
Less than A 15watts, 1.3A 1 watt
DIMENSIONS: 180w x 60h x 195d mm
WEIGHT: 2.5Kgs, transceiver only

TRANSMITTER

FREQUENCY RANGE: 144.000 - 148.995MHz - FM-2016A
144.000 - 145.995MHz - FM-2016E
TYPE OF EMISSION: F3
POWER OUTPUT: 15 watts (HIGH), 1 watt (LOW)
MODULATION CIRCUIT: Reactance modulation (Direct varicap FM of VCO)
DEVIATION: Set at factory to ±5KHz
SPURIOUS EMISSIONS: More than 60dB down from carrier
MICROPHONE: 600 ohms dynamic type with P/T switch
REPEATOR TONE: Adjustable internally 60 - 210H or 1300 - 1800Hz
Continuous or tone burst with internal switch
FM-2016A set at 100Hz, FM-2016E set at 1750Hz

RECEIVER

FREQUENCY RANGE: 144.000 - 148.995MHz FM-2016A and FM-2016E
TYPE OF EMISSION: F3
RECEIVER CIRCUIT: Double conversion superheterodyne
INTERMEDIATE FREQ: 1st 16.9MHz, 2nd 455KHz
RECEIVER SENSITIVITY: Less than 1uV input for S/N 30dB
Less than .25uV for 20dB quieting
SQUELCH SENSITIVITY: Less than .2uV
BANDWIDTH: ±8KHz (6dB)
SELECTIVITY: ±16KHz (70dB)
IMAGE RATIO: Better than 70dB
AUDIO OUTPUT: More than 1.5 watts, (THD 10%)
OUTPUT IMPEDANCE: 8 ohms (external speaker jack 4 - 8 ohms nominal)

ACCESSORIES

MICROPHONE: - Dynamic type, 600 ohms, with P/T switch
POWER CABLE: - with fuse holder and 2 prong metal connector
SPARE FUSE: - 5A
EXTERNAL SPEAKER PLUG: - Miniature phone plug type
MOUNTING BRACKET: - with mounting hardware, etc.
INSTRUCTION MANUAL: - with circuit diagram

KDK

Printed in Japan 81150

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1. GENERAL FEATURES

YOUR KDK FM-2016A, (OR E), IS A TWO METER FM TRANSCEIVER USING THE MOST UP TO DATE CMOS IC DIGITAL PLL CIRCUITRY FOR MOBILE AND BASE STATION USE. IT HAS BEEN COMPACTLY DESIGNED WITH EMPHASIS ON MAINTENANCE OF HIGH QUALITY AND YET BEING EASY TO USE AND INCLUDES THE MANY FEATURES DESCRIBED IN THE FOLLOWING.

(A) FREQUENCY COVERAGE AND CHANNELS

144.000 - 148.995MHz, transmit and receive (FM-2016A)
144.000 - 148.995MHz, receive, 144.000 - 145.995MHz transmit (FM-2016E)

Above in 10KHz steps plus 5KHz up capability for a total of 1,000 channels. (FM-2016E - 400 channels, transmit)

(B) DIGITAL FREQUENCY DISPLAY

Direct readout of operating frequencies using large size LED displays. Full solid state.

(C) AIRPLANE TYPE CO-AXIAL FREQUENCY CONTROLS

Operating frequencies selected by 10KHz, 100KHz, 1MHz and 5UP switches. Most frequently used 100KHz and 10KHz switches mounted coaxially on one shaft. These switches will not go below 0 or above 9 positions to facilitate frequency changing by feel only. Permits "eyes-on-the-road" at all times for mobile operation safety and is also useful for hams with impaired sight.

(D) ELECTRONIC MEMORY

An electronic memory using CMOS RAMs (Random access memory ICs) is provided any 4 out of the 1,000 channel capacity may be written in (stored) the memory at any time. A back up NICAD battery provided to retain memory contents while transceiver disconnected from any power source. Current drain only 25nA and internal automatic charging circuit keeps battery fully charged at all times.

(E) TRANSMITTER OFFSET FOR REPEATOR USE

+.6 and -.6MHz positions of the mode switch provide the normal + and - 600KHz shift in the transmitter frequency. Positions 1T-2R and 3T-4R are provided for utilizing the 4 channels of electronic memory to provide 2 pairs of non-standard shifts. In these positions the operating frequency is switched between memory chanels 1-2 and 3-4 automatically so that in position 1T-2R the set transmits on the frequency set up in memory channel 1 and receives on the frequency set up in memory channel 2 and likewise in the 3T-4R position. This feature provides for operating on non-standard shifts, and is also convenient when using the FM-2016 in conjunction with an up-converter, etc., for operation on 430MHz and other bands.

(F) SCANNING

A scanning system has been included to increase the utility of the transceiver. The four memory channels are scanned in one of two possible modes as selected by the SCAN switch. In scanning for a closed channel, the scanner will stop at the first channel in use encountered, and in the open scanning mode, it will stop at the first channel encountered which is not in use. A scan-hold feature is provided to permit immediate transmission after locating a channel by scanning.

(G) RECEIVER SECTION

Dual-gate MOS-FETs are used for the RF amplifier and first mixer and provides a superior inter- and cross-modulation characteristic as well as sensitivity. These characteristics are maintained constant across the wide frequency range covered by the use of an all electronic automatic tuning circuit using varicap diodes in the RF section. The combination of a monolithic crystal in the first IF and a commerical quality 15 pole ceramic filter in the 2nd IF results in extremely sharp selectivity. The 2nd IF amplifier is built up with discrete components rather than using an IC to keep input-output coupling to a minimum. A ceramic discriminator has been adopted for improved temperature stability as well as holding alignment over a long life period. An RIT (receiver incremental tuning control) and discriminator meter is useful when contacting off-frequency stations and an RF attenuator provides approximately 10dB of attenuation when using the transceiver under extreme inter- and cross-modulation situations.

(H) TRANSMITTER SECTION

Single conversion type using a balanced mixer. 5 stages of electronic tuning similar to that of the receiver together with a 4 stage low pass filter in the transmitter output results in a clean, spur-free signal. A latest type silicon transistor is used as the final amplifier and will hold up even under the extreme conditions of an infinite VSWR load. HIGH (15 watts) and LOW (1watt) is available with the front panel power switch, and is useful for reducing power for use in conjunction with a linear. True direct frequency modulation of the VCO results in a very distortion free modulation characteristic.

(I) MULTI-PURPOSE TONE OSCILLATOR

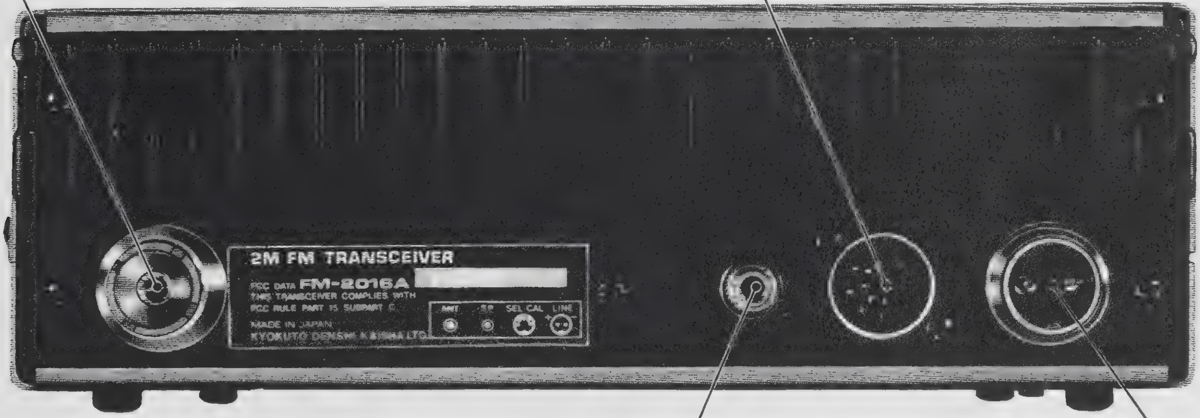
An internal tone generator system has been provided for accessing repeators. Two modes are selected by an internal switch (burst or continuous) and sub-audible or tone burst frequencies can be generated by changing capacitors. (FM-2016A pre-set at factory to 100Hz and FM-2016E pre-set to 1,750Hz.)

(J) ACCESSORY CONNECTOR

A 5 pin "DIN" type connector is provided on the rear panel for connection of a KDK SC-12A SEL-CALL (tone encoder/decoder) unit. Also useful for connection of phone-patch, touch-tone, remote headset-microphone combinations and similar type accessories.

ANTENNA RECEPTACLE SO-239 type coaxial connector for antenna. Will accept both metric and inch threaded plugs.

SEL-CALL CONNECTOR For connection of KDK SC-10 or SC-12A, Selcall unit (tone encoder/decoder). Also useful for connection of phone-patch, touch-tone, remote microphone/headset combinations, etc.


2M FM TRANSCEIVER
FCC DATA FM-2016A
THIS TRANSCEIVER COMPLIES WITH
FCC RULE PART 15 SUBPART C
MADE IN JAPAN
KYOKUTO DENSHI KAISHA LTD.
ANT
SP
SEL CAL
LINE

EXT SPEAKER JACK For connection of an external speaker for improved reception quality. Impedance 4 - 8 ohms. Miniature phone plug type plug is furnished as a standard accessory.

POWER CONNECTOR For connection of power supply using power cable furnished as standard accessory. Voltage supplied should be 13.8v dc, ±10%, with negative ground. Transceiver equipped with reverse polarity protection. *IMPORTANT: USE ONLY 5A FUSES!*

3. INSTALLATION AND OPERATING INSTRUCTIONS

(A) MOBILE INSTALLATION

1. Install mobile mounting bracket furnished with transceiver to any convenient under-dash or other location using self-tapping sheet metal screws (4 x 12mm) and washers provided. 3mm holes should be pre-drilled for the 4mm self tapping screws.

2. The transceiver should be secured to the bracket using the 2 winged screws provided. The bracket is designed so the transceiver can be slid forward or backwards in the grooves as well as varying the angle.

3. Connect antenna coax to the connector on the rear panel.

4. Connect power cable to power source. Red lead (+) and black lead (-). The cable should be connected to power at a low impedance point, preferably directly to the battery terminals or the main fuse block, otherwise extraneous noises maybe induced during transmission at high power.

5. Connect microphone to receptacle on lower right corner of front panel.

(B) HOME STATION USE

1. Small rubber feet have been provided on the transceiver to lift its bottom off the surface below and permit audio from the speaker to be heard. However, for easier access to the controls it is frequently helpful to tilt the control panel facing slightly upwards. A mobile mounting bracket used underneath the transceiver is useful for this and brackets are available optionally from your KDK dealor.

2. Connect antenna coax to the connector on the rear panel.

3. Connect power cable to a suitable supply such as a regulated power supply or battery. A good solid supply of 5A or more capacity is recommended.

4. Connect microphone to receptacle on lower right corner of front panel.

(C) OPERATING INSTRUCTIONS

1. PREPARATION: -- Set switches and controls as follows:

a)	POWER SWITCH	LOW or HIGH as desired
b)	RF ATT switch	OFF
c)	SCAN mode switch	OFF
d)	VOLume control	Approximate center position
e)	SQuelch control	Complete counter-clockwise position
f)	MODE switch	SIMP
g)	MEMORY switch	OFF
h)	MHz switch	Desired frequency
i)	100KHz switch	" "
j)	10KHz switch	" "
k)	5UP switch	" "
l)	WRITE switch	OFF
m)	RIT	Center, click-stopped position
n)	S.PWR/DISC switch	S.PWR position (pushed in)

2. RECEIVING: -- During the above preparation the meter lamp will light up, the frequency display LEDs and the RCV LED will be lit up and either random receiver noises or an incoming signal will be heard from the loudspeaker.

a) If no incoming signal is heard, vary the frequency using the front panel controls and locate an incoming signal. As soon as the signal is received, the meter will deflect upwards and indicate the relative strength of the signal.
b) Squelch: -- During no-signal conditions, the random noises heard from the speaker can be annoying. Turn the SQuelch control in a clock-wise direction until these noises are just extinguished. This sets the squelch threshold and only incoming signals will now be heard from the speaker. Turning the control up further

nals. Heavy squelch can be used to advantage in crowded city locations to squelch out weak inteferring signals.

c) RIT and DISCriminator Meter: -- Reception may be impaired if the incoming signal is off frequency, particularly with weak signals. In such instances pull out the RIT knob to switch the meter to the DISC position and adjust RIT knob to center the needle.

d) Memory WRITE Procedure: -- This transceiver has 1,000 channels, and any 4 may be written in to the memory, such as frequently used frequencies. For example, if it is desired to store the frequency of 146.520MHz in memory channel 1 --

1. Use frequency controls and set up 146.520MHz as read out on the DISPLAY.
2. Set MEMORY switch to 1. (If nothing had been stored in this channel previously, LED display will go black at this point.)
3. Switch WRITE switch to WRITE position and then return to OFF. As soon as switch is set to WRITE position, the LED display will show 146.520MHz indicating that the frequency has been written in to the memory channel.
4. Other sequences of writing in frequencies are equally satisfactory and will not damage the transceiver.
5. NOTE: Inadvertent operation of WRITE switch even with MEMORY switch in OFF position will result in selected frequency being written in to memory channel No. 4. This feature can be used to advantage for temporary storage of frequencies, retaining the other channels for storage of repeatedly used frequencies.

e) Scanning: --

1. Set MEMORY switch to SCN position next to memory channel 4.
2. Operate SCAN switch to CLOSE or OPEN as desired. The receiver will immediately start scanning each memory channel consecutively and the DISPLAY LEDs will show the frequencies in each of the memory channels as they are scanned. If the CLOSE mode was selected, scanning will cease at the first channel found with an incoming signal. As soon as this signal disappears, scanning will resume until another signal is received. In the OPEN mode scanning will cease at the first vacant channel encountered. Use CLOSE mode for continuous monitoring of up to 4 channels, and the OPEN mode for quickly locating a vacant channel.
3. If it is desired to transmit using a channel located by scanning, return the SCAN switch to the center OFF position. Transceiver will stay on the frequency (memory channel) located by scanning until MEMORY switch is moved off the SCN position.

f) RF ATTenuator Switch: -- Switching to the RF ATT position reduces sensitivity of the receiver by approximately 10dB's. This is useful when encountering inter- or cross modulation problems due to an extremely strong signal. This is also useful for squelching out weak interferring signals as well as in plotting a radiation pattern of a directional beam antenna.

3. TRANSMITTING: --

a) Select HIGH power (15 watts) or LOW power (1 watt) as desired.
b) Depress the press-to-talk (P/T) switch on the microphone and talk into the microphone in a normal voice. Recommend that the mike be held approximately 2inches (5 cm) from the mouth. A meter reading of approximately 8 indicates 15 watts power into a 50 ohm load. The XMT LED will light up as soon as the P/T switch is depressed indicating the transceiver is on transmit mode and will go out as soon as the switch is released indicating the transceiver has returned to the receive mode.

c) MODE switch: -- Simplex operations are conducted with the MODE switch in the SIMPlex position (Transmit and receive on same frequency). Select +.6 or -.6 as appropriate for working repeators with standard 600KHz offsets. If a non-standard repeator split is required, store the correct transmit and receive frequencies in the appropriate memory channels in accordance with the steps outlined in d) above and then switch the MODE switch to positions 1T-2R or 3T-4R as desired.

4. ADJUSTMENTS

ALL KDK TRANSCEIVERS HAVE BEEN CAREFULLY ALIGNED AND INSPECTED PRIOR TO SHIPMENT AND WE DO NOT RECOMMEND ATTEMPTING FURTHER ADJUSTMENT WITHOUT THE PROPER TOOLS AND TEST EQUIPMENT. HOWEVER, AGING OF PARTS MAY RESULT IN DRIFTING OF SOME CONTROLS PERIOD OF USE AND THE FOLLOWING DESCRIBED ADJUSTMENTS MAY BE MADE IN THE FIELD. ANY OTHER ALIGNMENT OR TUNE-UP SHOULD NOT BE ATTEMPTED WITHOUT THE PROPER TESTING EQUIPMENT AND WE RECOMMEND RETURN TO THE AUTHORIZED DEALOR OR NATIONAL DISTRIBUTOR.

a) RECEIVE "S" METER SENSITIVITY CONTROL

Adjusted to read full scale with a 20dBm input. Adjust control VR1 of Main unit in clock-wise direction to increase sensitivity.

b) DISC. METER ZERO BALANCE ADJUSTMENT

Adjust by varying control VR6 of Main Unit. Short gate terminal of Q12 to ground.

c) RIT ALIGNMENT

Set control to center click-stop position, pull out on knob and switch meter to DISC position. Apply correct frequency input to antenna receptacle and adjust L9 of Main Unit to center needle on zero. (Apply hot soldering iron tip to proximity of tuning slug of this coil to melt sealing wax on slug. CAUTION: Overheating may damage coil.)

d) MICROPHONE AMPLIFIER GAIN

Adjust using control VR7 of Main Unit. Turning in clock-wise direction increases gain. This control is best left untouched unless a severe change of gain is noted as for instance when changing to a different type microphone. Over increasing will result in constant clipping and distortion of transmitted signal.

e) TRANSMITTER DEVIATION CONTROL

Adjusted for ±5KHz at factory. Turning control VR8 of main unit in a clock-wise direction will increase deviation.

f) TRANSMITTER LOW POWER

Continuously adjustable between 1 watt and maximum power using control VR1 of Main Unit. (Do not set below 1 watt). Clock-wise rotation increases power output.

g) TRANSMITTER HIGH POWER

Continuously adjustable between 1 watt and maximum power using control VR4 of Main Unit. Turning in clock-wise direction increases power. (Do not set below 1 watt.)

h) TRANSMITTER POWER METER

Adjusted at factory to give reading of 8 for a power output of 15 watts into 50ohm dummy load. Setting can be changed by varying control VR2 of Main Unit.

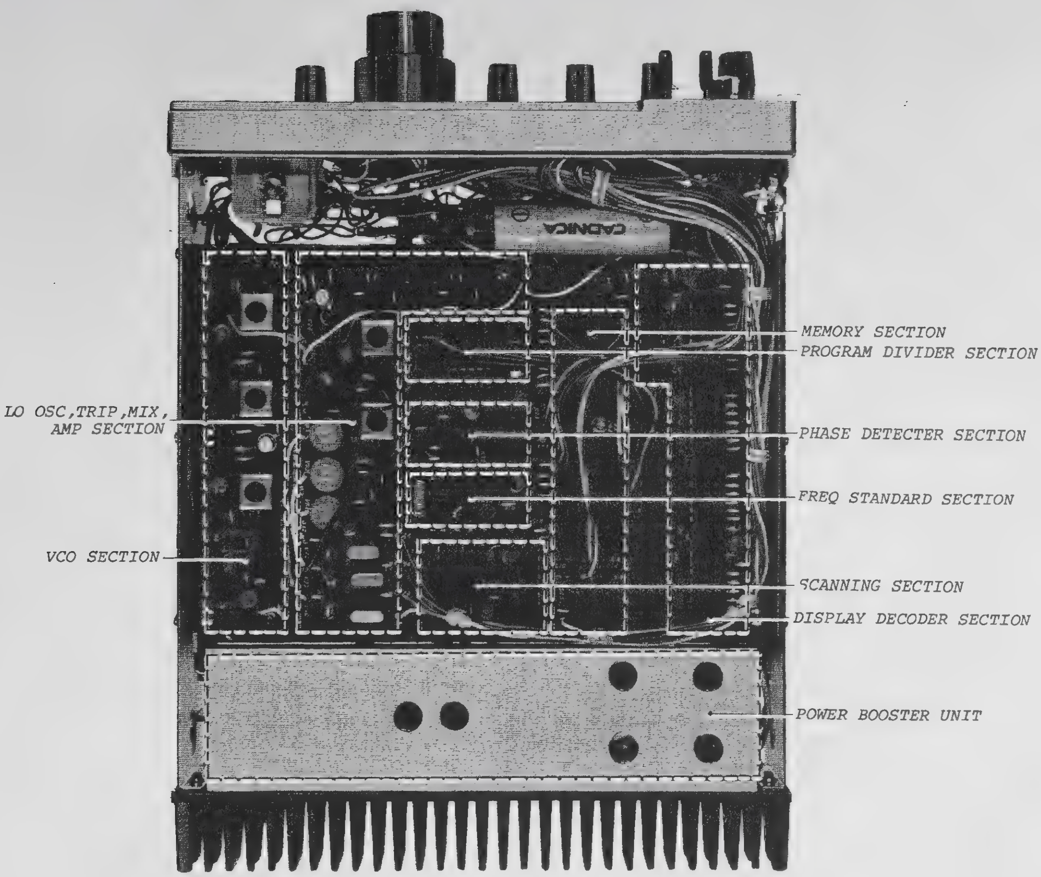
i) MULTI-PURPOSE TONE OSCILLATOR

The tone oscillator is IC-4 located on the main unit. It is designed to provide either a burst or continuous tone as selected by the internal switch. Its frequency can be set by changing capacitors and adjusting the trim-pot according to the following table:

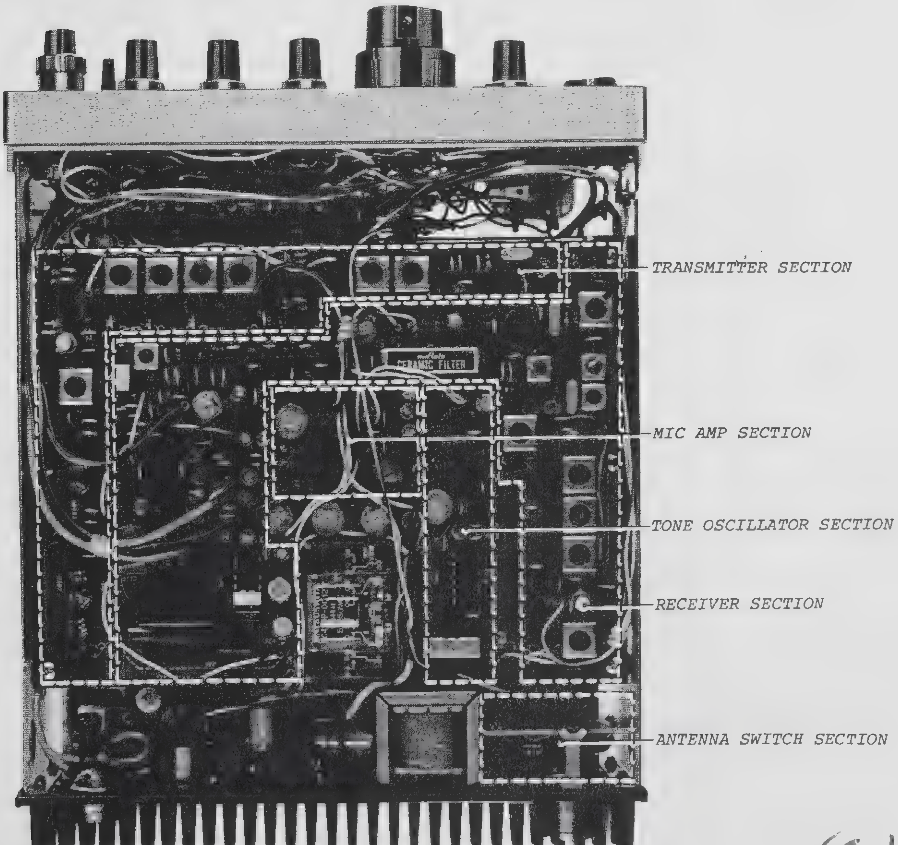
C-124	*C-125*	*Frequency Range*	*Remarks*
.068mfd	*.033mfd*	*Appx. 60 - 130Hz*	*FM-2016A set at 100Hz*
.068 "	*nil*	*" 90 - 210Hz*	*"*
.0047 "	*nil*	*" 1300 - 1800Hz*	*FM-2016E set at 1750Hz*

5. INTERNAL VIEWS

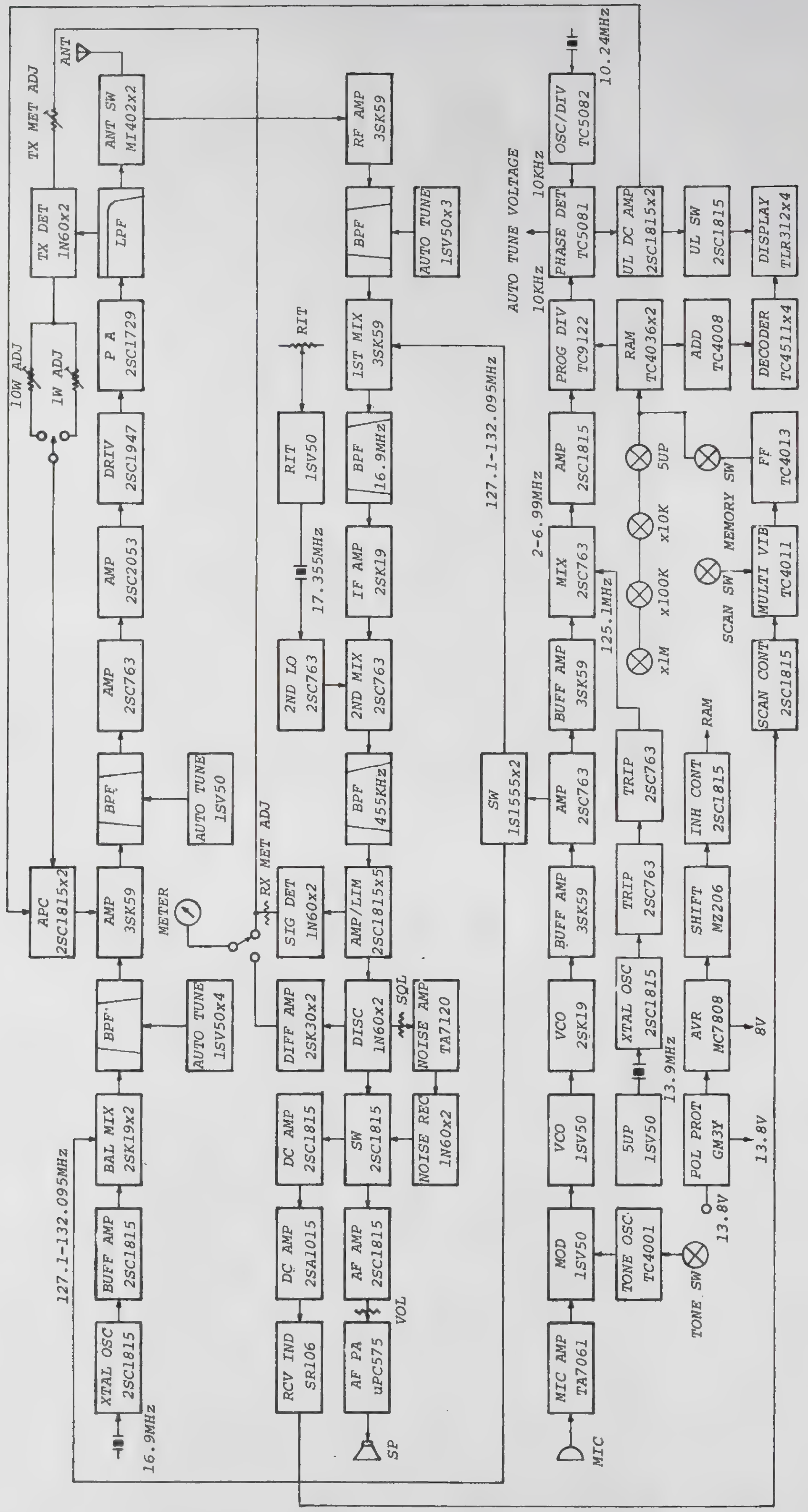
TOP VIEW



BOTTOM VIEW



6. BLOCK DIAGRAM



7. CIRCUIT DESCRIPTION

PLEASE REFER TO BLOCK DIAGRAM ON PAGE 12 AND THE SCHEMATIC WHEN READING THIS SECTION.

(A) GENERAL

The receiver first local oscillator is the VCO controlled by the PLL to provide the correct injection frequency to the mixer. The receiver is of the double conversion superheterodyne type with a 1st IF of 16.9MHz and a 2nd IF of 455KHz.

The transmitter is a single conversion type mixing the output from a 16.9MHz oscillator with the output from the VCO, with modulation being applied directly to the VCO.

(B) MAIN UNIT

This printed circuit board contains the receiver circuits, the transmitter exciter stages, the tone oscillator, the power supply circuits and the APC circuits.

1) Receiver Circuitry: -- Input from the coax receptacle on the rear panel is fed to the input terminal of the receiver through the low pass filter and diode switching circuits on the SW PCB. This signal is amplified by Q1, a dual-gate MOSFET. The local oscillator signal, (127.1 - 132.095MHz) is applied to gate 2 of Q2, the first mixer, with the output from the RF amplifier being applied to gate 1. The signals are mixed and results in a 16.9MHz 1st IF Signal. This signal passes through the monolithic crystal filter XF with a bandwidth of ±10KHz/3dB, is amplified by a JFET, Q3, and is applied to the base of the 2nd mixer, Q5. The base of Q5 is also fed the 2nd local oscillator signal of 17.355MHz which is generated by Q4. Q5 converts the 1st IF to the second IF of 455KHz. Varicap D4 is in the oscillator circuit of Q4 and a voltage controlled by the RIT control VR is applied to D4 via pin 12. The RIT control varies the oscillator frequency by approximately ±5KHz. The output of mixer Q5 is passed through the 15 pole ceramic filter CF which has a bandwidth of ±8KHz/6dB. Q6, 7, 8, 9 & 10 are the 2nd IF amplifier and limiter stages from which the signal is fed to the ceramic discriminator CD and diodes D10 and 11. Output from the discriminator passes through the de-emphasis circuit R43 and C50, the audio amplifier Q11, and is fed to the volume control via pin 19. The audio returns from the volume control via pin 25 and is then amplified by IC-1, the power amplifier. It is then outputed to the speaker via pin 16.

2) RF Attenuator: -- This circuit functions by lowering the bias voltage on gate 2 of the RF amplifier by operation of the swtich via pin 5 and results in a gain reduction of approximately 10dB's. It is effective in minimizing the effects of interference from strong local signals as well as squelching out weak interference, etc.

3) "S" Meter Circuit: -- The IF signal is picked off the collector of Q7, the 2nd IF amplifier and is rectified in a voltage doubling circuit D5 and D6 and then applied to the meter to give indications of relative signal strength. VR1 adjusts meter sensitivity and normally is set for a 20dBm signal input to give a full scale reading. (Note that meter sensitivity is not linear.)

4) Squelch Circuit: -- Noise present at the discriminator is picked up through the series and parallel tuned circuits C48-L13 and C49-L14 and is then sent to the front panel squelch control through VR5 and pin 17. The signal is returned to the receiver via pin 23 and is then fed to IC-2 for noise amplification. The amplified signal is rectified in a voltage doubler circuit D12 and D13 and is then fed to the base of the squelch switching transistor Q14. During no input conditions to the receiver, receiver noises are rectified, which results in increasing the potential of Q14, connecting the emitter through to the collector. This results in shorting out the base of Q11 and thus grounding both the bias and the signal at this transistor which ceases to amplify and effectively cuts out the receiver noises from being passed to the final amplifier. As soon as an incoming signal is received and the receiver is quieted, the voltage on the base of Q14 drops, the connection between its emitter and collector is broken, normal bias is applied to the base of Q11 and

audio output from the discriminator is amplified and normal reception through the speaker takes place.

5) RCV LED Circuit: -- The base voltage of audio amplifier Q14 is amplified by two stages of direct coupled transistors, Q13 and Q12, and drives the RCV LED via pin 24. This LED provides an indication when an incoming signal is being received even if the volume control is turned completely off, or when using the transceiver in conjunction with a KDK SC-12A or SC-10 SEL-CALL unit.

6) Discriminator Meter Circuit: -- DC output from the discriminator is amplified by the differential d-c amplifier Q15 and Q16 and is applied to the RIT VR through pins 21 and 22. It then drives the discriminator meter to provide an indication of the incoming signal's frequency. VR6 is the "zero balancer" for the differential amplifier and should be adjusted so that the meter reads zero after first grounding the gate of FET, Q16.

7) Transmitter Circuitry: -- The transmitter is a single conversion, narrow band FM transmitter using direct modulation of the VCO (127.1 - 132.095MHz) which in turn is controlled by the PLL.

8) Microphone Amplifier: -- Audio from the microphone enters the transmitter through pins 8 and 9 and is then fed to the amplifier, IC-3 through the gain control, VR7. C113 and the input impedance of IC-3 combine to provide pre-emphasis. Output from the amplifier/limiter is passed through a 3KHz low pass filter, C120, L27 and C121 to remove harmonics created by clipping and is then fed to the modulator varicap in the VCO circuit via pins 10 and 11.

9) Multi-purpose Tone Oscillator: -- IC-4 and Q27 is the tone oscillator. 2 NOR gates of IC-4 make up a multivibrator. Its oscillating frequency is determined by C124, C125, R104 and VR10. (See values tabulated versus frequency in 4. i). Output from the oscillator is fed via pin 11 to a low pass filter R103, C123 to remove harmonics created by the multivibrator. This filtered output is bufferred by Q27 and then fed to the low pass filter of the microphone amplifier through the level control, VR9.

The circuit can provide either a sub-audible tone or a higher frequency tone burst. It can further be switched to provide either a continuous tone for the duration of the transmission or a short burst at the beginning of each transmission by operation of the internal switch mounted on the Main Unit PCB.

The oscillator is controlled by the voltage applied by the TONE/RF ATT switch through pin 46. For the tone burst, C128, R108 and 2 NOR Gates of IC-4 make up a "one shot multivibrator" with a period of approximately .5 seconds.

The FM-2016A transceivers are set at the factory for a sub-audible tone of 100Hz and the FM-2016E transceivers are set for a 1750Hz tone burst.

10) APC Circuit (Output Control): -- RF power is sampled by the diode D2 in the power booster module and is fed to the d-c amplifier Q24 and Q25 via pin 37. The signal is then applied to the base of a buffer, Q21 and by varying the base voltage controls the output. VR3 sets the low power output and VR4 sets the high power output through the main power switch and pins 14, 15 and 27. The unlock signal from the synthesizer unit is applied to the APC through pin 27.

11) Transmitter Exciter: -- Transistor Q17 and crystal X2 combine to generate a 16.9MHz signal which is amplified by Q18 and is fed to the balanced mixer Q19 and Q20 through tuned circuits L15 and L16. The TX local oscillator signal from the synthesizer unit is also applied to the mixer through pins 6 and 7. (127.1 - 132.095MHz). The mixer converts these inputs to the desired signal frequency (144.0 - 148.995). This output is passed through 4 sucessive stages of electronic tuned circuits, inductors L18, L19, L20, L21 and varicaps D14, D15, D16 and D17 which are peaked at the operating frequency to minimize spurs. This circuit is similar to the circuits employed in the receiver and are effective in attenuating all but the desired frequency. The output is amplified by a dual gate MOS-FET, Q21 and passes through another auto-tuned circuit, L22 and D18 and is amplified to approximately 0.3 watts by Q22 and Q23. This signal is applied to the power booster module through terminal TX.

12) Power Booster Module: -- Output from the Main Unit is applied to the booster through pins 1 and 2. It is then amplified by Q1 and Q2 to attain an output of over 15 watts. The output is matched to 50 ohms through step-up coil L6 and matching capacitors VC5 and VC6 and is then fed through a 3 stage low pass filter, L7, L8 and L9 and associated capacitors. Output from the filter is outputed from pin 3 and is applied to the antenna receptacle through the SW Unit. A portion of this output is picked up by diodes D1 and D2 in a voltage doubling circuit and is used to drive the power indicator (meter) and the APC circuit through pin 4 of the booster and pin 27 of the Main Unit. Reading of the power meter is set by VR2 and is connected to the meter through pin 13 of the Main Unit.

13) Antenna Switching (SW) Unit: -- RF power switching diodes D1 and D2 are used in a solid state switching circuit to minimize mis-matching in the antenna changeover circuits. The received signal is fed from the antenna receptacle through the low pass filter L3, C6 and C5 and then to the receiver input of the Main Unit through C4, L2 and C3. During reception, no d-c current flows through D1 and D2 and thus the 2 diodes are in a cut-off condition and D1 prevents the flow of the signal into the transmitter. For transmitting, a control voltage is applied to D1 through L1 and results in a current flow through D1, L2 and D2. D1 conducts to pass the transmitter signal to the low pass filter through C4. L2 also appears in the output circuit of D1 but presents a high impedance to the signal thus the transmitter signal passes through to the low pass filter and the antenna receptacle. Any signal leaking through L2 is grounded as D2 is also conducting and thus does not feed in to the receiver input circuitry.

(C) SYNTHESIZER UNIT

The receiver 1st local oscillator signal and the transmitter local oscillator signal are centrally generated by this unit which consists of the VCO circuit, crystal standard oscillator, the programmable divider, the phase comparator, the unlock detector, the RAMs, the scanning, display and decoder circuits.

1) VCO Circuit: -- The VCO circuit consists of Q1, L2, C3 and D2. The d-c output from the phase comparator, IC-2, is applied to D2 and locks the oscillator frequency. Capacitor C2 and varicap D1 are connected in paralel with the VCO and audio from the microphone amplifier is applied to D1 via pins 1 and 2 to derive direct FM of the VCO. The VCO's output is bufferred by Q2, amplified by Q3 and then applied to the receiver through switching diode D3 via pins 18 and 19. Output to the transmitter is switched by diode D4 and applied to the transmitter through pins 20 and 21.

2) Frequency Conversion and Amplifier Circuits: -- A portion of the output from Q3 is picked up through C22 and bufferred by Q4. It is then applied to the PLL mixer, Q5. A separate PLL local oscillator signal (SIMP = 125.1MHz, -.6 = 124.5 and +.6 = 125.7MHz) is mixed with the output from Q4 and thus converts the signal to the PLL IF of 2.0 - 6.99MHz. The PLL local oscillator signal is derived by Q19 oscillating in the 13.7MHz band, tripling by Q10 and again tripling by Q11. This signal is then applied to the PLL mixer. The frequency of the local oscillator is controlled by X4 = 13.9MHz for the simplex frequency of 125.1MHz, X3 = 13.833MHz for the -600KHz frequency of 124.5MHz and X2 = 13.966MHz for the +600KHz frequency of 125.7MHz, these crystals being switched by diodes D5, D6 and D7. Also diodes D10, D9 and D8 are connected in series with these crystals and raise the PLL local oscillator by 5KHz through operation of the 5UP switch. The 5UP voltages to these varicaps are set by individual controls, VR3, VR2 and VR1 to obtain exactly 5KHz. The 2 to 6.99MHz PLL IF signal is passed through the low pass filter, L6 C31 and C32, and then amplified to achieve sufficent levels to drive the programmable divider, IC-1.

3) Frequency Standard and Divider Chain: -- IC-3 oscillates at 10.24MHz in conjunction with crystal X-1. It is divided by 1/1024 by the pre-scaler contained in IC-3 to achieve a standard signal of 10KHz and then is applied to IC-2, the phase comparator.

4) Programmable Divider: -- The 2 to 6.99MHz PLL IF signal is applied to pin 2, the input to the programmable divider section of IC-1. This divider divides the signal by a factor of 200 to 699 as determined by the program data input H and L levels applied to pins 3 through 13 of the divider. These levels are set up by the front panel MHz, 100KHz and 10KHz switches through the RAM IC's. The IC-1 program input pins 3 through 6 are for the 10KHz digit, 7 through 10 the 100KHz and 11 through 13 the MHz digits respectively and accept H level BCD coded inputs.

5) Phase Comparator: -- IC-2 is the digital phase comparator. The PLL IF signal divided by "N" is applied to 2 and the 10KHz standard is applied to pin 7. IC-2 compares the two signals and outputs a d-c voltage from pin 3 in proportion to the phase difference between the two signals. This d-c voltage is passed through the active low pass filter formed by pins 1 and 2 of the IC and is used as the VCO and receiver electronic tuning circuit control voltages.

6) Unlock Circuit: -- When the PLL circuit is out of lock the VCO is oscillating in an unstable off-frequency condition thus proper transmitting and receiving is not possible. In order to prevent off-band transmissions, etc., circuitry is provided to stop the operation of the transmitter amplification stage. When the PLL is properly locked in, pin 4 of the phase comparator, IC-2, is mainteained constantly at approximately the power supply voltage. Thus Q7 is conducting and its emitter and collector are connected through. Thus, no voltage difference is observed between the emitter and ground of the following d-c amplifier, Q8. When the PLL is out of lock, a downward facing 10KHz pulse appears on pin 4 of IC-2. This pulse switches Q7 on and off. This pulse is smoothed by the combination of R30 and C55 so that the emitter of Q8 rises to approximately the power supply voltage. This voltage created as a result of the PLL going out of lock is applied to the APC circuit of the Main Unit in order to inhibit the transmitter as well as being applied to pin 4 of the decoder IC's to blank out the LED frequency display to advise the operator the PLL is out of lock.

7) Frequency Control and Memory Circuits: -- This transceiver is designed with mobile operations in mind, thus all frequency control operations are possible by operation of front panel controls. Output from these controls are BCD coded. The coaxially mounted 10KHz and 100KHz controls program the RAM IC data input terminals directly. A 5 position switch with diode mattrix is used for the MHz switch and its output is also applied to the RAM IC input terminals. The last digit, single KHz, uses data input pins 7 through 10 of IC-11. 5KHz up is the only combination used. Data input terminals 3 through 6 of IC-11 is for the 10KHz digit and in the same manner, pins 7 through 10 and 3 through 6 of IC-12 is for inputting 100KHz and MHz information. Data information is by H level inputs.

When front panel controls are utilized for direct operations, the memory switch is in its OFF position. The memory switch OFF position applies an H level to the memory by-pass terminals, pins 11 of RAM IC's IC-11 and IC-12. Thus the data input applied to the RAM IC's appear directly at the RAM IC output terminals and thence are inputted to the programmable divider, IC-1. This output is also applied to the decoders in order to drive the LED display units.

For memory operations, pins 1 and 23 are driven by H level binary codes to provide 4 words (4 channels) of memory. Selection is by operation of the memory switch through channels 1 through 4. Output from the switch is converted by means of a diode mattrix to provide the proper binary coded signals to the address terminals, pins 1 and 23. Operation of the memory switch from OFF to the memory channels changes the level at the memory by-pass terminals from H to L, disabling the bypass function. Operation of the WRITE switch WR applies an H level to pin 2 of the RAM IC's and writes in the information present at the input terminals to the memory *cells. Returning the WR switch to its OFF position presents the memorized data to the output terminals.*

The memory IC's used in this transceiver are CMOS RAM IC's and memory content will be lost if power is removed from the RAM IC's. A NICAD battery is provided internally to maintain power to the RAM's even when the transceiver is disconnected from any external power source. When power is applied and the main power switch is ON, 8 volts d-c is applied to pin 24 through diode D16. When the power switch is turned OFF, the power through the voltage shift circuit R113 and D17 drops below 6 volts, Q15 conducts and changes the RAM "chip inhibit" terminals 22 from a L level to a H level and reduces the RAM current consumption to 24nA which is sufficient to retain memory content. Also, when the main power switch is turned ON, the NICAD battery is charged through R111 at a rate sufficient to re-charge the battery in a short period.

Output data from the RAM's is applied to the decoders for conversion of the BCD coding to that required to drive the seven segment LED units as follows: -- 1KHz digit to IC-4, 10KHz digit to IC-5, 100KHz digit to IC-6 and the MHz digit to IC-8 through an adder, +2, to IC-7. Voltages to drive the LED's are applied to the LED's through current limiting resistors, R52 - R81. Pin 4 of the decoders are driven to the L level by Q14 when the PLL unlocks and this blanks out all of the LED units except for the decimal point.

8) Scanning Circuitry: -- Scanning is performed by switching each of the RAM IC's address terminals. 2 NOR gates of IC-9 form a multivibrator with its frequency determined by the time constant of R87 and C91. Pulses from this multivibrator drive the flip-flop circuit of IC-10 which in turn drives the address lines of the RAM's. the squelch signal from the receiver is passed through Q12 and then 2 NOR gates of IC-9 to control oscillation of the multivibrator. During scanning, switching transistor Q13 is conducting in order to disable the memory by-pass function.

(D) POWER SUPPLY CIRCUITS:

The full power supply voltage of 13.8 volts is applied to audio output IC, IC-1, the relay and the power booster unit. All other circuits are powered by regulated 8 volts supplied by IC-1 mounted on the inside of the rear panel, either directly, or through P/T relay mounted on the Main Unit.

8. SPECIFICATIONS : MODEL FM-2016A/E

GENERAL

FREQUENCY COVERAGE: 144.000 - 148.995MHz, 10KHz steps & +5KHz, 1000 channels.

144.000 - 148.995MHz, Ditto above receive only, FM-2016E
144.000 - 145.995MHz, Transmit, FM-2016E

SEMI-CONDUCTORS 11 FET, 33 Transistors, 17 IC's and 65 Diodes
MEMORY CHANNELS: 4 Channels
SCANNING: Scanning of 4 memory channels for open and closed channels.
FREQUENCY STABILITY: Better than +.002%
USEABLE TEMPERATURE RANGE: -20°C to +60°C
POWER SOURCE: DC 13.8v, ±10% (negative ground)
ANTENNA IMPEDANCE: 50 ohms nominal, unbalanced
CURRENT CONSUMPTION: Less than .4A receive standby, .6A maxium volume
Less than A 15watts, 1.3A 1 watt
DIMENSIONS: 180w x 60h x 195d mm
WEIGHT: 2.5Kgs, transceiver only

TRANSMITTER

FREQUENCY RANGE: 144.000 - 148.995MHz - FM-2016A
144.000 - 145.995MHz - FM-2016E
TYPE OF EMISSION: F3
POWER OUTPUT: 15 watts (HIGH), 1 watt (LOW)
MODULATION CIRCUIT: Reactance modulation (Direct varicap FM of VCO)
DEVIATION: Set at factory to ±5KHz
SPURIOUS EMISSIONS: More than 60dB down from carrier
MICROPHONE: 600 ohms dynamic type with P/T switch
REPEATOR TONE: Adjustable internally 60 - 210H or 1300 - 1800Hz
Continuous or tone burst with internal switch
FM-2016A set at 100Hz, FM-2016E set at 1750Hz

RECEIVER

FREQUENCY RANGE: 144.000 - 148.995MHz FM-2016A and FM-2016E
TYPE OF EMISSION: F3
RECEIVER CIRCUIT: Double conversion superheterodyne
INTERMEDIATE FREQ: 1st 16.9MHz, 2nd 455KHz
RECEIVER SENSITIVITY: Less than 1uV input for S/N 30dB
Less than .25uV for 20dB quieting
SQUELCH SENSITIVITY: Less than .2uV
BANDWIDTH: ±8KHz (6dB)
SELECTIVITY: ±16KHz (70dB)
IMAGE RATIO: Better than 70dB
AUDIO OUTPUT: More than 1.5 watts, (THD 10%)
OUTPUT IMPEDANCE: 8 ohms (external speaker jack 4 - 8 ohms nominal)

ACCESSORIES

MICROPHONE: - Dynamic type, 600 ohms, with P/T switch
POWER CABLE: - with fuse holder and 2 prong metal connector
SPARE FUSE: - 5A
EXTERNAL SPEAKER PLUG: - Miniature phone plug type
MOUNTING BRACKET: - with mounting hardware, etc.
INSTRUCTION MANUAL: - with circuit diagram

CAUTION--MEMORY BACK UP BATTERY

The memory back up battery has been installed at the factory. If the transceiver is to be stored without use for an extended period, remove the battery and store in a cool location to prevent possible damage to the transceiver by corrosion.

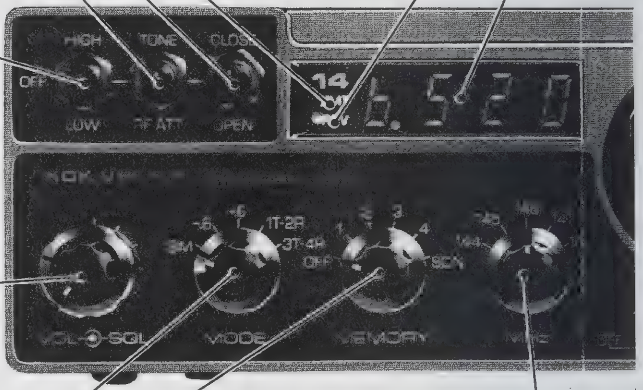
2. OPERATING CONTROLS AND FUNCTIONS

TONE/RF ATT SWITCH *Center position OFF. Switching to WRITE position "stores" frequency set up by the MHz, 100KHz, 10KHz and 5UP switches in memory channells. ATT position reduces receiver sensitivity by approximately 10dBs.*

SCAN SWITCH *Center position OFF (Hold). In CLOSE position, scanning will stop at first memory channel with an incoming signal. Sensing of channel condition utilizes squelch signal. OPEN position for locating vacant channel.*

XMT LED *Indicates when transmitter is operating. LED is actuated by P/T relay.*

POWER SWITCH *Center position OFF. Up position turns on main power to transceiver and also selects HIGH power output of 15 watts. Down position turns on main power and selects LOW power of 1 watt.*



SQUELCH/VOLUME CONTROL *Squelch control mutes receiver when no signal being received. Turning in clock-wise direction increases depth of threshold.*

Volume control increases volume when turned in a clock-wise direction.

MODE SWITCH *SIMP position for simplex (transmit and receive on same frequency) operations. +.6 and -.6 positions for standard 600KHz up and down transmitter offsets.*

NOTE: DISPLAY WILL SHOW ONLY RECEIVE FREQUENCIES IN THE +.6 AND -.6 POSITIONS.

1T-2R and 3T-4R positions for non-standard offsets using 4 memory channels. 1T-2R uses memory channel 1 for transmit and 2 for receive frequency. Set MODE siwtch on SIMP for writing in frequencies in respective memory channels then switch to 1T-2R or 3T-4R position as desired.

MHz SWITCH *Controls MHz digit of operating frequency.*

MEMORY SCAN SWITCH *OFF position puts 10KHz, 100KHz, MHz and 5UP switch in control of frequency. Positions 1 through 4 select memory channels 1 through 4 and display contents of memory channel on DISPLAY LED's.*

SCAN postion for scanning of frequencies stored in memory channels. Frequencies will be displayed as they are scanned.

r-
e-

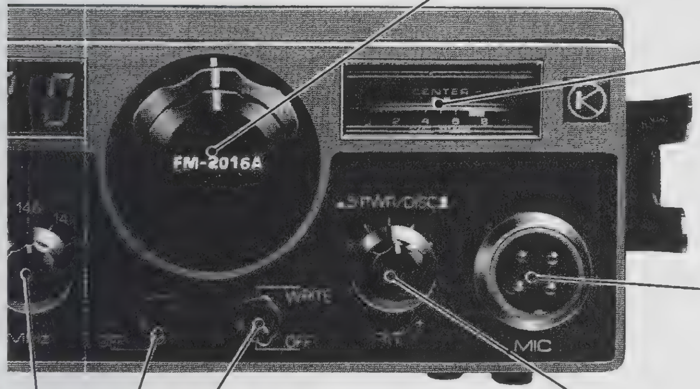
RCV LED Indicates when a signal is being received. LED is actuated by squelch signal.

10KHz/100KHz CONTROLS Large knob controls 100KHz digit, and small knob controls 10KHz digit. Knobs will not go below 0 or above 9 to permit frequency changing by feel only for driving safety during mobile operations.

FREQUENCY DISPLAY 4 digits of large LED's display frequency selected by the MHz, 100KHz, 10KHz and 5UP controls. Also displays frequencies written (stored) in memory channels when MEMORY switch in positions 1 - 4.

THREE-IN-ONE METER Controlled by switch mounted on RIT control. In normal RIT knob pushed in position, meter reads relative incoming signal strength for receive, and transmitter output during transmission.

When RIT knob pulled out, meter functions as discriminator meter.



MICROPHONE CONNECTOR Four pronged receptacle for connection of microphone.

ng

WRITE SWITCH Switching to WRITE position with memory channels 1 - 4 will write in the frequency selected by the frequency controls in whatever memory channel selected by the MEMORY/SCAN switch.

NOTE: Operation of this switch with memory switch in OFF position will still result in the frequency set up by the panel controls to be written in to memory channel 4. This feature can be used to advantage for making a quick QSY.

RIT/DISC CONTROL Click-stopped at center for center frequency. Moving to + and - varies receiver frequency + and - approximately 5KHz.

Pulling knob out switches meter to give discriminator readings. Full deflection of meter + or - indicates received signal 5KHz above or below correct frequency.

5UP SWITCH Switch to control 1KHz digit. OFF for 0KHz and 5UP for 5KHz.

KDK

C-MOS MICRO-PROCESSOR CONTROLLED

DIGITAL PHASE LOCKED SYNTHESIZER

2-20-84

2m VHF FM TRANSCEIVER

MODEL FM-2033

INSTRUCTION MANUAL

KDK KYOKUTO DENSHI CO., LTD.
21-25, 6 chome, Honcho, Nakano-ku, Tokyo 164, Japan

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1. GENERAL FEATURES

The FM-2033 continues the KDK tradition of obtaining maximum operating features while retaining ease of operation, all in a small front panel and overall package size. The KDK design team achieved this by calling on their many years of experience in designing compact, VHF, mobile transceivers. The maximum use of multi-functional controls with co-axial knobs rather than a profusion of push buttons, and, in-house developed microprocessor programming provides a unique control system stressing "eyes-on-the-road" operations to enhance driving safety.

NOTE: This manual is written for the (A) version of the FM-2033. Where information differs for the (E) version sold in most European countries, information is added following an asterisk "".*

1. USER PROGRAMMABLE FUNCTIONS

Basic operating parameters can be re-set by the user by changing diodes located on a compact, plug-in, INITILIZATION module. These are:

a. Dialing steps, 2.5 - 40KHz. Set at factory to 5KHz, *12.5KHz (In multiples of 2.5KHz.)

b. Low frequency band edge (LFBE). Lowest frequency for transmit and receive. Can be set 142.00 - 155.0MHz. Set at factory to 142.00MHz, *144.00MHz.

c. Transmit high frequency band edge (THFBE). Highest transmit frequency. NOTE: Actual highest frequency is one step below limit set by THFBE mattrix. Can be set 142.00 - 155.00MHz. Set at factory to 150.00MHz, *146.00MHz.

d. Receive high frequency band edge (HFBE). Can be set 142.00 - 155.00MHz. Set at factory to 150.00MHz, *146.00MHz.

e. Offset frequency (for ± offset mode). 100KHz - 1.6MHz. In multiples of 100KHz. Set at factory to 600KHz.

f. Programmable DIAL EDGE mode. Dial operation mode at LFBE and HFBE can be set for "wrap-around" or "non-wrap" mode. Set at factory to "non-wrap" mode.

2. SPEED BUTTON

Speeds up dialing rate to 100KHz for rapid dialing to a widely separated frequency.

3. RIT (Receiver incremental tuning)

A digital RIT to shift receiver only in 1KHz steps. Max shift ± 1 dialing step. Operates in all modes; VFO, MEMORY and CALL.

4. REVERSE BUTTON (DIAL KNOB)

Push on dial knob to monitor duplex transmit channels. Operates in ± offset and AxB duplex modes. Also, RIT.

5. PROGRAMMABLE BAND SCANNING

Band scanning limits are frequencies written in to memory channels #5 and #10. Any portion or all of total frequency coverage can be selected. Set at factory to 144.500 and 148.500MHz, *145.500MHz.

6. TWO MODE SCANNING

Scanning in busy and open modes permits maintaining watch on busy channels as well as searching for vacant channels.

7. ELEVEN MEMORY CHANNELS

CALL memory plus 10 memory channels. Memory channels in two groups A and B. Groups A and B may be scanned separately or in total as set by memory mode switch. In AxB mode memory channels 1 - 5 are set for receiving and transmitting on corresponding channel 6 - 10. Permits memory of 5 non-standard offset frequency pairs.

MEMORY information includes transmit offset +, - or simplex as set by memory mode switch.

8. INTERNAL MEMORY BACK UP NICAD BATTERY

All memory channels and dial frequency data retained by internal back-up NICAD battery. The battery is automatically charged during operation of transceiver. Memory contents are retained even if the transceiver is disconnected from power source.

9. LCD FIVE DIGIT DISPLAY

Front panel LCD display for for good visibility in bright sunlight. Five digit display for indication down to 100Hz digit providing full read-out of 12.5KHz channel spacing frequencies.

10. TWO MODES OF MEMORY CHANNEL INDICATION

Memory channel number, or frequency, as selected by function switch.

11. CALL CHANNEL

Extra memory for storing frequently used frequencies. Instant recall by a flick of function switch. Stored frequency can be changed by dialing up new frequency, setting function switch to CALL, and pushing WRITE switch.

12. INTERNAL PLUG IN TONE OSCILLATOR

Switched on by pushing TONE button. 2033A - CTCSS encoder (Tunable, set at 103.5Hz ex-factory.) 2033E - 1750Hz crystal controlled tone burst. Can be set to provide manual controlled continuous tone. (See 7.1, page 12.

2. OPERATING CONTROLS AND INSTALLATION

2.1 OPERATING CONTROLS AND FUNCTIONS

This section describes functions of various knobs, switches, indicators and connectors on front and rear panels of the FM-2033. Photographs of panels are numbered identically with the paragraphs.

(1) FUNCTION SWITCH

Switches function of DIAL, (2).

VFO Dial knob (2) selects frequency. (Dialing)
M-CH Dial knob selects memories. Display (4) shows memory numbers.
M-FR Dial knob selects memories. Display shows memory frequencies.
CALL Call channel selected and dial disengaged.

Electronic alarm beeps at lowest and highest frequency, lowest and highest memories, also upon reaching channel edge for RIT.

(2) DIAL KNOB (AND REVERSE SWITCH)

Knob dials frequencies or memories as selected by FUNCTION switch (1) and RIT button:

a. In 5KHz steps, *12.5KHz
b. In 100Khz steps when SPEED, (17), engaged.
c. 1KHz steps, receiver only, when RIT, (16), engaged.

REV switch when pushed. Reverses receive and transmit frequencies for offset and RIT (for both the ± offset and AxB offset modes.)

(3) SCAN SWITCH

BUSY: Scanning starts. Stops upon reaching channel in use. Resumes soon as channel clears. To resume scanning while signal continues, step up one channel using dial knob or microphone UP button.

HOLD: Center, scanning "off" position for manual control.

OPEN: Scan starts. Stops upon reaching vacant channel. Resumes as soon as signal appears on channel. To resume scanning while channel continues vacant, step up one channel using dial knob or microphone UP button.

NOTE: In units supplied to certain countries, a 3 second delay has been built in to SCAN RESUME. In such units, the OPEN scan feature is inoperative. (See paragraph 7.5, page 12)

Type of scan set by FUNCTION SWITCH, (1), as follows:

VFO: Band scan. Scan limits are frequencies set in memories 5 and 10. Scans between these two freq. Band scan increments are same as dialing steps.

M-CH: Memory scan. DISPLAY (4), shows memory no.
SHOWS CHANNEL # ONLY

M-FR: Memory scan. DISPLAY (4), shows memory freq.

SCAN SKIP: In memory scanning, unwanted channels may be skipped to speed up scan repetition rate. Store lower band edge frequency in memory to be skipped. For example 142.000, *144.000.

(4) DISPLAY LCD

Shows frequencies in five digits in DIAL, M-FR and CALL positions of FUNCTION switch (1). Shows memory number in M-CH position. (Changes to show frequency when a new frequency is written in to memory and returns to memory number as soon as WRITE button is released.)

(5) RECEIVE LED

Lights up while signal being received. (Receiver unsquelched.)

(6) TRANSMIT LED

Lights up during transmitting. (Lights up at band edges but transmitter inoperative to prevent an out-of-band transmission.)

(7) SIGNAL/POWER INDICATOR

Dual function bar type LED meter to show relative strength of incoming signal AND transmitter output.

(8) MICROPHONE CONNECTOR

Connector for microphone. Includes 13.8 volt power source for KDK TM-2 tone encoder microphone. (DM-100 UP/DOWN microphone provided in some countries, in which case the TM-2 may be optionally available from distributor or dealor.)

(9) HIGH LOW BUTTON

Selects transmitter output power. HIGH, 25 watts; LOW, 5 watts. Both can be reset for intermediate values. Do not set at less than 5 watts.

(10) TONE BUTTON

Selects tone for repeator use. Type of tone operation set by plug-in module. TONE-2033A: CTCSS - frequency varied by internal trim-pot. TONE-2033E: crystal controlled 1750HZ tone burst. (See page 12 for manual tone control.)

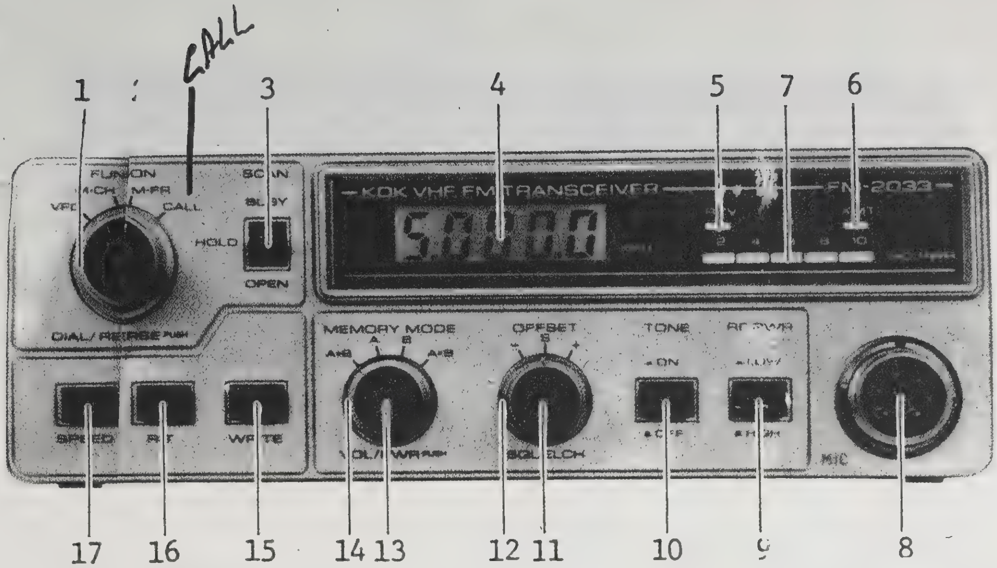
(11) SQUELCH CONTROL

Mutes receiver noises during no signal conditions. Should be set at point where noise is just squelched out when advanced in a CW direction from extreme CCW position.

(12) OFFSET SWITCH

S Simplex. Transmit and receive on same freq.

+ Transmit 600KHz above receive frequency.



FRONT PANEL

- Transmit 500KHz below receive frequency.

DISPLAY (4), switches between receive and transmit frequency. Amount of offset re-programmable by changing diodes in INT-2033 module. If offset exceeds upper or lower band limits, display shows ----- as soon as P/T is keyed and cannot transmit.

(13) VOLUME/POWER CONTROL.

Volume increases as knob turned in a CW direction.

Push knob to turn power on. Push again to turn off.

(14) MEMORY MODE SWITCH

A+B	Selects all memories, 1 through 10.
A	Selects memories 1 through 5
B	Selects memories 6 through 10
AxB	Duplex using memories. Receive on memories 1 through 5 and transmit on corresponding 6 through 10. DISPLAY (4), switches between receive and transmit frequencies.

(15) WRITE BUTTON:

Push to write desired frequency to CALL and memory channels.

PRIORITY WRITE-IN: Pushing this button while in VFO mode of function switch, will write dialed frequency in to memory #1. Suggest memory #1 be used for storage of frequencies to be used only temporarily.

(16) RIT (Receiver Incremental Tuning)

When engaged, DIAL (2) and UP/DOWN buttons (22) (23), shifts receiver in 1KHz steps. Operates in DIAL, M-FR and CALL functions. Maximum shift ± one dial step.

NOTE 1: When RIT engaged, RIT may be cleared and receiver returned to center by switching FUNCTION switch (1) to other position momentarily, then returning to original position.

NOTE 2: RIT must be disengaged in order to DIAL or select memories.

(17) SPEED SWITCH

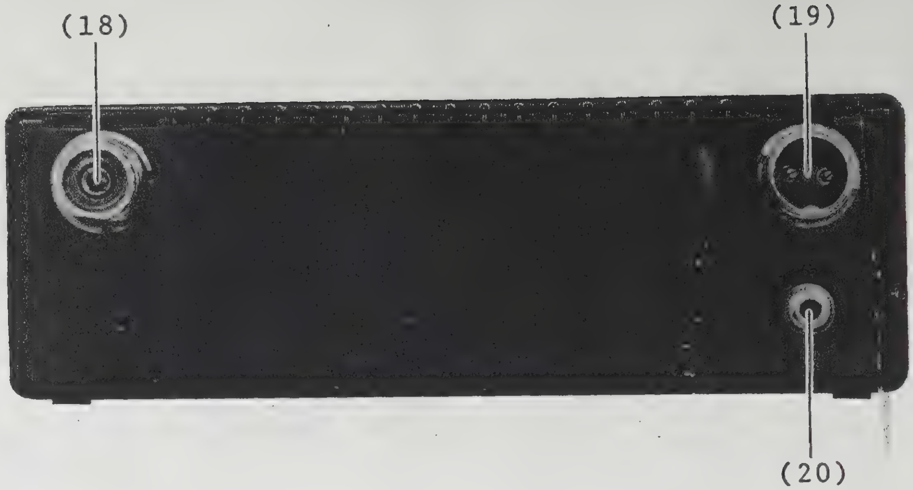
Increases dialing rate to 100KHz per step. Use for rapid dialing to a widely separated frequency. (This function inoperative during band scanning.)

(18) ANTENNA CONNECTOR

SO-239 type. Will accept both metric and inch threaded plugs.

(19) DC CONNECTOR

Receptacle for connecting DC 13.8 volts. Use cable supplied with transceiver. Connect red lead to positive and black lead to negative terminal. Use only 7A fuses.



REAR PANEL

(20) EXTERNAL SPEAKER JACK

A mini plug to fit this jack is included as a standard accessory.

(21) P/T (Press to talk) SWITCH

Press to key transmitter.

(22) DOWN BUTTON

A momentary push will:

a. VFO: Lower frequency by one step.
b. M-CH: Select next lower memory. Also M-FR.
c. RIT: Lower frequency by 1KHz.

If button is held down, above action repeats, slowly at first and then faster, until button is released or maximum RIT shift is reached.

(23) UP BUTTON

Same action as down button except direction of change is upwards.

(24) TONE ENCODER BUTTONS

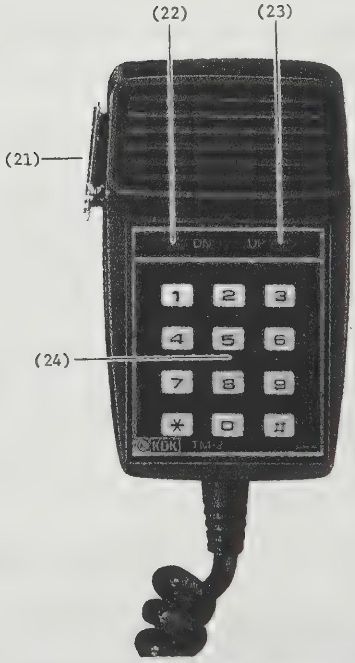
These buttons transmit standard telephone dialing tones. Frequencies are as shown below. Pushing buttons, keys transmitter and not necessary to hold down P/T switch, (20). Transmitter continues to be keyed for about .7 seconds after button released, permitting smooth key-in of a sequence of numbers.

LOW TONES HIGH TONES

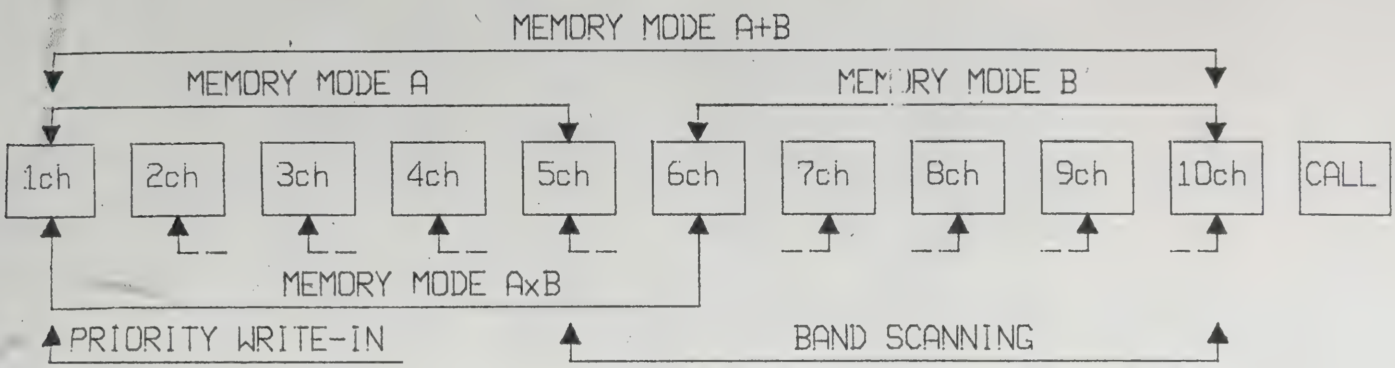
	1209	1336	1447Hz
697	1	2	3
770	4	5	6
852	7	8	9
941	#	0	*

NOTE: Where DM-100 is standard microphone provided with the transceiver, the TM-2 may be optionally available from distributor or dealor.

DM-100 MICROPHONE



TM-2 TONE ENCODER MICROPHONE



FUNCTIONAL LAYOUT, MEMORIES

2.2 MEMORY CHANNEL RELATIONSHIPS

(1) CALL CHANNEL

Dial desired frequency. Set FUNCTION switch to CALL Push WRITE button.

(2) MEMORY CHANNELS

① Dial desired frequency. Set ② FUNCTION switch to M-CH and select desired memory. ③ Push WRITE button. ④ DISPLAY will change to selected frequency signifying the frequency has been written in. As soon as write button is released, display will return to showing memory channel number.

(3) BAND SCAN LIMITS

Desired upper and lower limits for band scanning should be written in to memories #5 and 10. NOTE: When designating the highest frequency as the upper limit, use frequency 1 step down from the HFBE, i.e., if HFBE=149.000 then use 148.995MHz, *145.9875MHz.

(4) SCAN SKIP, MEMORY SCANNING

Reducing number of channels scanned increases relative speed of scanning. Thus scanning in the A or B mode is twice as fast as scanning in the A+B mode. Speed can be further increased by removing unnecessary channels from scanning sequence. This is accomplished by writing in the LFBE frequency to the unwanted memory, i.e., 142.000, *144.000MHz.

(5) ENTERING OFFSET MODE TO MEMORIES

Select desired frequency in VFO mode. Set FUNCTION switch to M-CH and select desired memory channel. Set mode switch to Simplex, + or - as desired. Push WRITE switch.

(6) ENTERING OFFSET MODE TO CALL MEMORY

Select desired frequency in VFO mode. Set FUNCTION switch to CALL. Set mode switch to Simplex, + or - as desired. Push WRITE switch.

2.3 MOBILE INSTALLATION

(1) Install mounting bracket included with unit under dashboard or convenient location using four, 4 x 12mm, self tapping screws located in samll plastic bag in microphone carton. A 3mm hole should be pre-drilled to use these self tapping screws.

(2) Mount the transceiver in bracket using two black thumbscrews provided. Select best angle of installation for easy operation. The bracket, while very simple in design, is very flexible to match various mounting situations.

(3) Connect antenna feed cable to connector on rear panel. The SO-239 type connctor will accept both metric or inch threaded plugs.

(4) Connect red/black cable packed in microphone carton to power source. Red lead is + and black - (negative ground). These should be connected to point with lowest possible impedance such as directly to the battery, or as a 2nd choice, the fuse box.

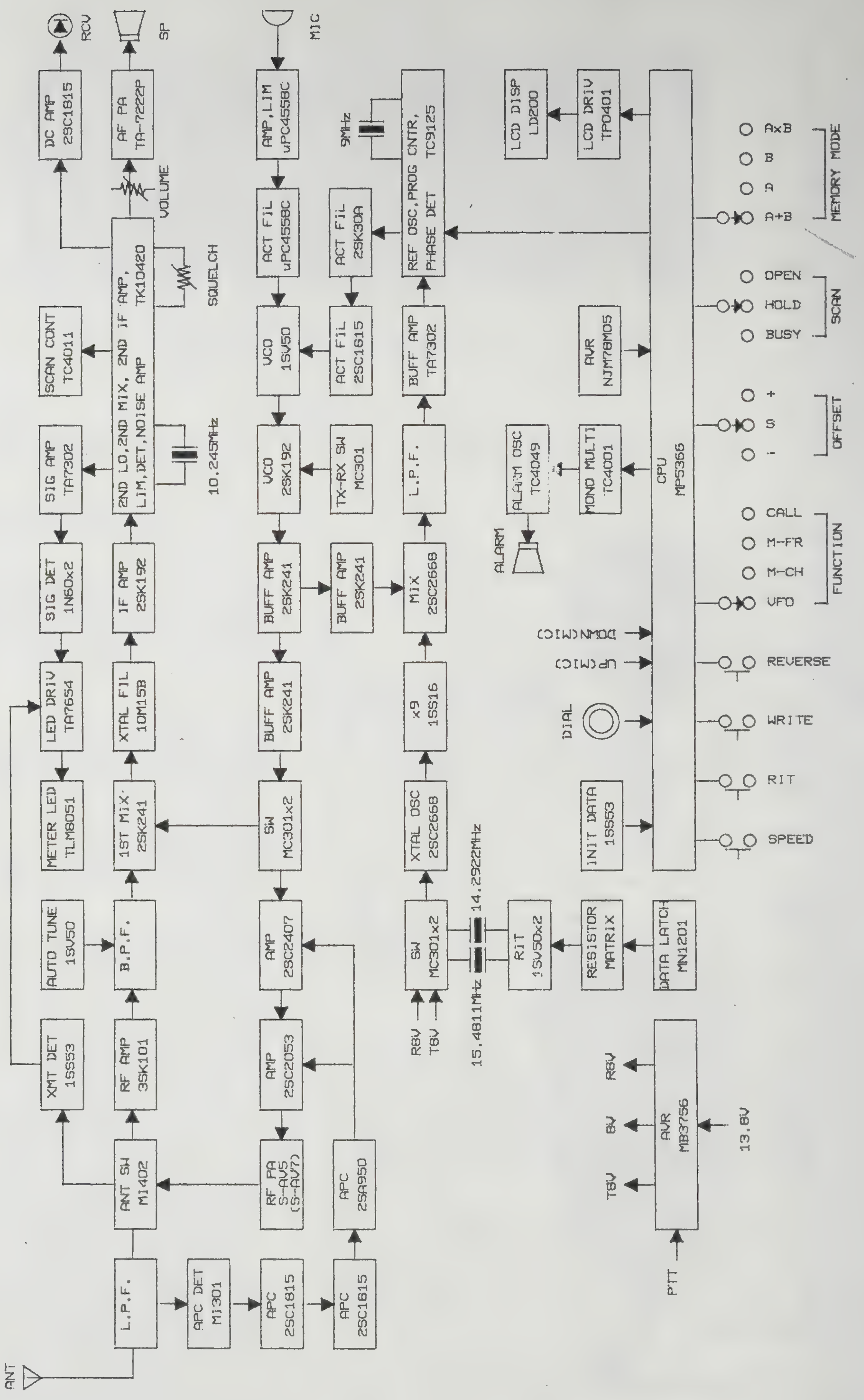
(5) Plug mike into connector, (8) on front panel.

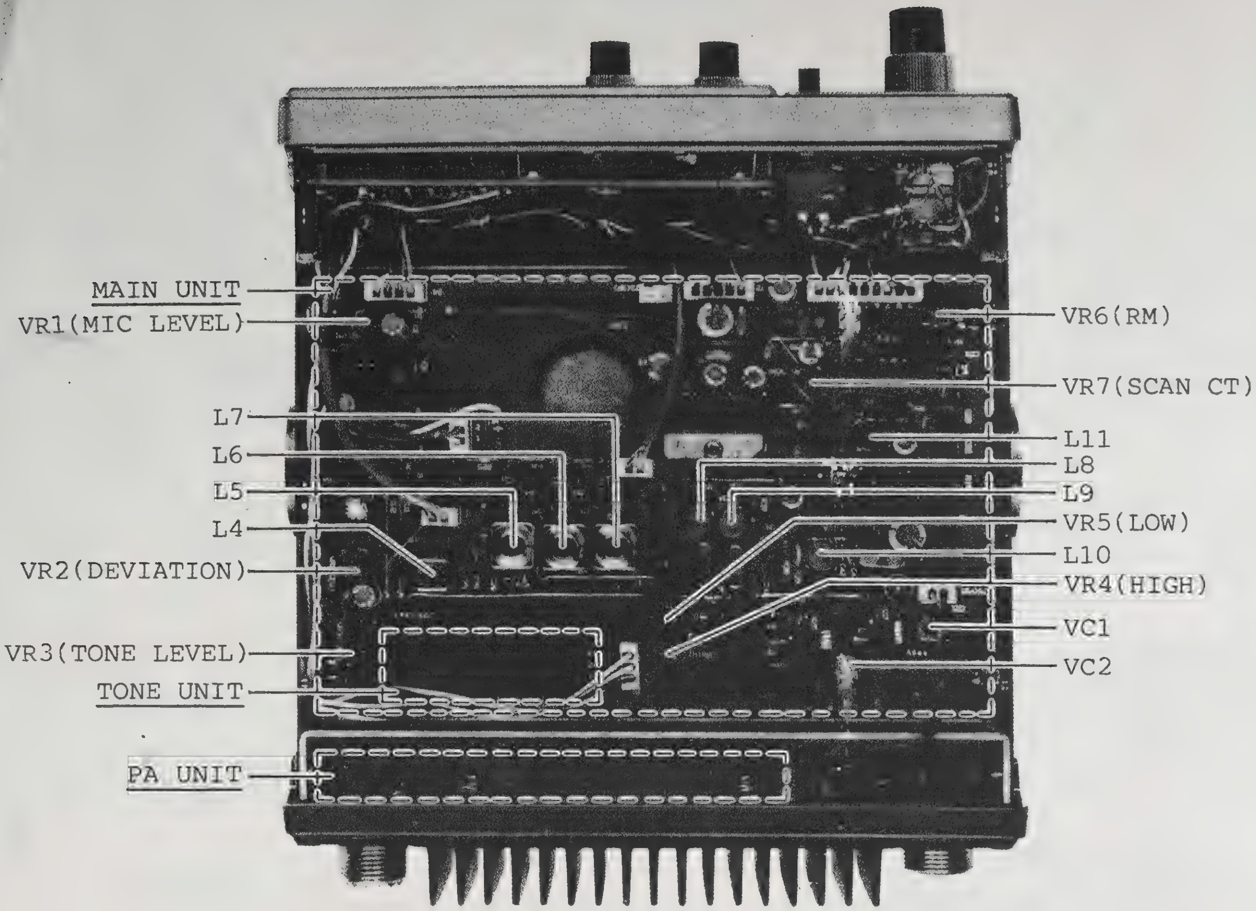
2.4 FIXED INSTALLATION

(1) Rubber feet are provided on the bottom of unit. It is frequently easier to operate if the unit is placed so front panel is tilted upwards. An extra mobile bracket can be used for this as shown in the cover photograph.

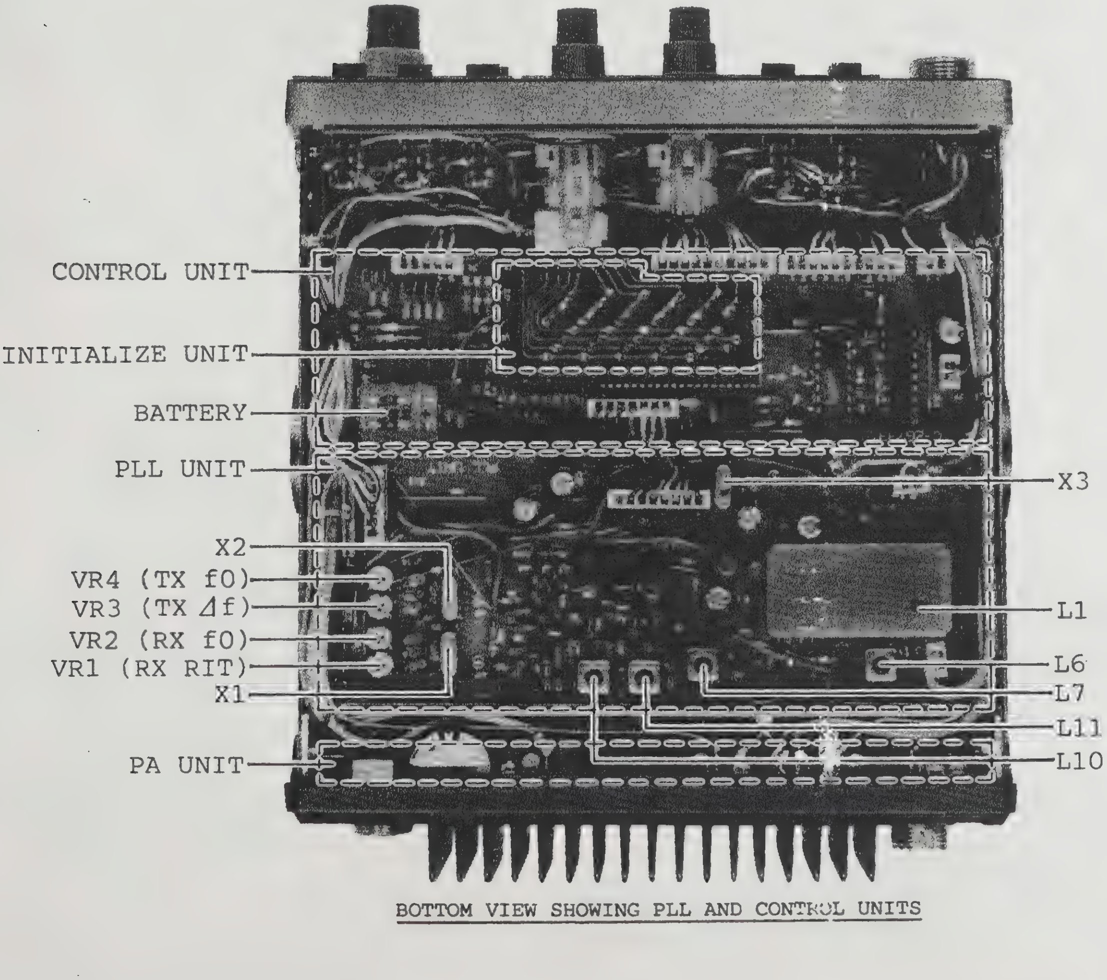
(2) A good battery or regulated power supply of sufficient capacity should be used. A power supply of insuficient capacity may result in damaging the transceiver.

(3) For other information, refer to paragraphs 3, 4 and 5 of the preceding section.


ANT
L.P.F.
ANT SW M1402
XMT DET 1SS53
RF AMP 3SK101
AUTO TUNE 1SV50
B.P.F.
1ST MIX 2SK241
METER LED TLM8051
XTAL FIL 10M15B
LED DRIV TA7654
IF AMP 2SK192
SIG DET 1N60x2
SIG AMP TA7302
SCAN CONT TC4011
2ND LO,2ND MIX, 2ND IF AMP, LIM,DET,NOISE AMP TK10420
10.245MHz
SQUELCH
VOLUME
DC AMP 2SC1815
RCV
AF PA TA-7222P
SP
MIC
AMP,LIM uPC4558C
ACT FIL uPC4558C
VCO 1SV50
VCO 2SK192
BUFF AMP 2SK241
BUFF AMP 2SK241
SW MC301x2
AMP 2SC2407
AMP 2SC2053
RF PA S-AV5 (S-AV7)
APC DET M1301
APC 2SC1815
APC 2SC1815
APC 2SA950
ACT FIL 2SK30A
ACT FIL 2SC1815
TX-RX SW MC301
BUFF AMP 2SK241
9MHz
REF OSC,PROG CNTR, PHASE DET TC9125
BUFF AMP TA7302
L.P.F.
MIX 2SC2668
x9 1SS16
XTAL OSC 2SC2668
SW MC301x2
RBV
TBV
15.4811MHz
14.2922MHz
RIT 1SV50x2
RESISTOR MATRIX
DATA LATCH MN1201
LCD DISP LD200
LCD DRIV TP0401
AVR NJM78M05
ALARM OSC TC4049
MONO MULTI TC4001
ALARM
DOWN(MIC)
UP(MIC)
DIAL
INIT DATA 1SS53
CPU MP5356
AVR MB3756
RBV
BV
TBV
13.8V
PTT
AxB
B
A
A+B
MEMORY MODE
OPEN
HOLD
BUSY
SCAN
+
S
-
OFFSET
CALL
M-FR
M-CH
VFO
FUNCTION
REVERSE
WRITE
RIT
SPEED



TOP VIEW SHOWING MAIN UNIT WITH 2033A TONE MODULE



BOTTOM VIEW SHOWING PLL AND CONTROL UNITS

5. CIRCUIT DESCRIPTION

5.1 RECEIVER

RF AMPLIFIER: -- Signal from antenna connector is fed through low pass filter, L6, L5, L4, C20, C17, C16 and C15 and is applied to connector J5 of MAIN unit. Signal is then amplified by MOS-FET Q6. It then passes through a 3-stage electronic auto tuned circuit L5 through L7 and D4 through D6. This circuit keeps sensitivity constant over the wide band coverage, also keeps out unwanted signals. Signal is then applied to gate of Q2.

1ST MIXER: -- The 130MHz band injection voltage from the VCO is input through connector J7 and is applied to source of mixer, Q7. The 10.7MHz output from the mixer is extracted from drain of Q7.

1ST IF AMPLIFIER: -- The converted signal is passed through a combination of two monolithic crystal filters, XF, with a selectivity of ±15KHz/3dB, and LC filtering, L8 and L9, to further attenuate adjacent channel interference. It is then amplified by Q8, and passed on to next stage, IC4.

2ND MIXER THROUGH DETECTOR: -- IC4 is a one chip multi-purpose LSI. It contains the 2nd mixer, 2nd local oscillator, IF amplifier, limiter, quadrature detector, squelch noise amplifier and muting circuitry. Very few external components are needed improving reliability. The 1st IF signal inputs to IC3 from pin 16 and is mixed in the IC with the 2nd local oscillator signal. The 2nd L.O. is controlled by crystal X, connected between pins 1 and 2. A converted 455KHz signal appears at pin 3 and is fed through ceramic filter, CF, with a pass-band of +-6KHz/3dB. It re-enters IC3 through pin 5 and is amplified and limited. Treated signal appears at pins 7 and 8 and is demodulated by the combination of internal LSI circuitry and quadrature coil, L9. Demodulated audio appears at pin 9 of IC4.

AUDIO AMPLIFIER: -- Audio, from pin 9 of IC4, is applied to pin 7 of IC1, and passes through the de-emphasis circuit in IC1. It re-appears at pin 8 of IC1 from where it is taken to front panel volume control. It is set to proper level by the control and then connected to pin 4 of IC7. Output from IC2 is taken from pin 9 and connected to the speaker via the external speaker jack.

SQUELCH CIRCUITRY: -- The demodulated signal from pin 9 of IC4 is connected to pin 7 of IC3 from where it is connected to the internal low-pass filter and squelch control circuitry. Front panel squelch control is connected to pins 1 and 4 of IC3 and is used to set squelch threshold levels.

"S" METER CIRCUITRY: -- The signal for the meter is taken from output side of ceramic filter, CF, and applied to pin 1 of IC5, where it is amplified and then ouput from pin 6. It is rectified in a voltage doubler circuit, D10 and D9, set for meter sensivity by VR6 and is connected to pin 3 of IC1 of the DISPLAY unit. This signal is A/D converted by IC3 which drives the LED bar-meter, D3.

RCV LED CIRCUIT: - The squelch muting signal at pin 13 of IC4 of the main unit switches transistor Q9 to drive the RCV LED, D1, of the DISPLAY unit. LED lights up when squelch opens.

SCAN CENTER DETECTOR CIRCUIT: - This transceiver is designed to operate on channel steps as close as 2.5KHz. If SCAN control relied solely on incoming signal, scanning may stop prematurely before reaching center of channal. The center detector prevents this in busy mode scanning. Output from detector and RCV LED are fed to an "AND" circuit so scanning halts only at center of channel. A signal, (4V ±1V), is obtained from pin 9 of IC4 and is connected to pins 1 and 2 of IC6. IC6 outputs an inverted signal at pin 3 only when its input is 4V ±1V. This is connected to pin 13 of the BUSY control. Output from control is at pin 11 and is connected to pin 9 in an AND circuit with the RCV signal applied to pin 8. Output appears at pin 10 only when both pins 9 and 8 are high which is used to control scanning. Center detector is not used in OPEN scanning. Pin 12 is set to L level, so scanning is controlled only by the RCV LED signal.

5.2 TRANSMITTER

MICROPHONE AMPLIFIER: - Audio signals from the mike are adjusted for level by control VR1 on MAIN unit. It is amplified by IC1 and shaped by pre-emphasis circuit and limiter using active filter, IC2. VR2 sets deviation. This audio is connected to PLL unit through connector J6 and is applied to D60 of PLL to frequency modulate the VCO.

TRANSMITTER EXCITER STAGES: -- The VCO signal from the PLL is input through J7 and after switching by D7 is amplified by transisters Q4 and Q5 to about .5 watts. This is output through connector, J9.

POWER AMPLIFIER: -- The output of the MAIN unit from J9 is applied to IC1 of the rear panel power amplifier unit and amplified to more than 25 watts. Its output passes through antenna switching diode D1 and then through the low pass filter, L4 - L6, C15 - C17 and C20 to remove harmonics. It is then conncted to the antenna connector.

APC (AUTO POWER CONTROL): - A portion of the output is sampled by diode D4 which provides a rectified output from pin 10 to J8-1 of Main Unit. Signal is fed through the Hi and Lo power controls VR4 and VR5 and is then amplified by transisters Q1 through Q3. The amplified output controls supply voltage to transistors Q4 and Q5 to achieve power control.

Transmitter stop signal from CPU is applied to APC through J8-3 and lowers voltage supplied to Q4 and Q5 effectively stopping transmission.

5.3 PLL SECTION

VCO CIRCUIT: -- The VCO circuit is formed by L1, D1 and Q1. It is set to the 130MHz band for receiving. D2 sets it to the 140MHz band for transmitting. VCO output is bufferred by Q2, Q3, and is output from J1. VCO frequency is controlled by applying a DC voltage to varicap diode D1 locking VCO in to PLL.

PLL LOCAL OSCILLATOR AND MIXER: -- PLL L.O. is a VXO, D4, X2, and Q5. Frequency is set by varying voltage on D4 by control, VR4. RIT voltage from computor via J9-3 is applied to D4 through VR3 and varies f0 in 1KHz steps.

For transmitting, VXO is X1, D3, Q5. Frequency is set by varying bias on D3 by VR2. A fine tune control voltage from CPU (for 2.5KHz and 5KHz steps) via J9-3 is set by VR1 and applied to D3 to fine tune the local oscillator.

Output of Q5 is multiplied by 9 using Schottky barrier diode D7 and is applied to mixer, Q6, through band-pass filter, L10 and L11. Output from VCO is bufferred by Q4 and applied to Q6 to obtain a converted output of 3.67 - 9.67. Unwanted spurs are removed by low-pass filter L12, C30 and C31. Output from filter is amplified by IC1 and applied to pin 9 of IC2 as the phase comparator signal.

PLL CIRCUITRY: -- IC2 is a one-chip LSI containing the standard frequency oscillator and divider, phase comparator, programmable divider and data latch. The standard is controlled by crystal X3 connected between pins 2 and 3. Signal is divided by 900 as set by data applied to pins 4 - 8, to obtain a 10KHz standard. Converted output from pin 6 is applied to pin 9 and is divided according to data from CPU applied to pins 4 through 8. Divided signal is fed to phase comparator with 10KHz standard. A pulse is output from pin 15 which relates to phase difference between the two signals. Pulse is converted to dc by active low pass filter Q8 Q9, and is used to control VCO frequency as well as receiver electronic tuning circuits. Voltage, TV (Tuning Voltage), is output via TP3. Pin 13 outputs an "H" level during PLL unlock and switches Q7 to lower the supply voltage on Q3 to stop output from the VCO.

5.4 CPU CONTROL SECTION

All control functions are centered around the CPU, MP-5366, with KDK in-house developed programming. Data inputs are K1 - K8 and L1 through L8. Time division outputs are R0 - R15, and decode outputs O0 - O7. Control functions are achieved by connecting various input and output terminals.

INITIALIZATION DATA FOR CPU: - Outputs R4, R7 - R11 are connected to input K1 - K8 by BCD coded diode mattrixes on initialize module to command various actions to CPU as tabulated in Table (1).

CPU DATA OUTPUT: -- See Table (2).

IN/OUT COMMANDS: - See Table (3).

INTERNAL MEMORY BACKUP NICAD: - As soon as power is switched off, 5V supply starts to drop. Q2 is cutoff and voltage across R12 is connected to K8 through D5 to advise CPU of power switch off. CPU switches all outputs to high impedance. As supply voltage drops, Q1 is cutoff and CPU HLT terminal switches to H level. CPU is backed-up by internal NICAD and changes to low power consumption mode.

ALARM SIGNAL CIRCUIT: -- The alarm signal is output from CPU terminal R6. These pulses are widened by one shot multivibrator IC3-3, IC3-4 and switches multivibrator IC3-1, IC3-2 to generate a 4KHz signal. This is bufferred by IC2-3 to drive the alarm beeper.

LCD CIRCUITRY: - 4bit parallel data from the CPU, STD, CE and the framing clock signals from IC2-1/IC2-2 are applied to LCD driver, TP0401 to dynamically drive the 5 digit LCD, LD-200.

TABLE (1) PROGRAM INITIALIZATION

ITEM	INPUT	OUTPUT	UNIT	MULTIPLIER	SET AT FACTORY
STEP	R11	K1 - K8	2.5KHz	x1 - 16(0)	x2, *x5 5, *12.5KHz
OFFSET	R10	K1 - K8	100KHz	x1 - 16(0)	x6 600KHz
THFE	R9	K1 - K8	1MHz	x1 - 16(0)	x9, *x6 150, *146MHz
HFE	R8	K1 - K8	1MHz	x1 - 16(0)	x9, *x6 150, *146MHz
LFE	R7	K1 - K8	1MHz	x1 - 16(0)	x3, *x4 142, *144MHz
UHF	R4	K4	-	Offset base frequency changed to 500KHz	
EDLS	R4	K2	-	Commands "wrap-around" dial mode	

* 2030 (E)

TABLE (2) DATA OUTPUT

ITEM	DATA	TIMING	ACTION
RIT	O4 - O7	R10, R11	IC4 (O4 - O7) outputs RIT data (BCD) and IC4 (R10, R11) outputs latching pulse. Resistor mattrix of IC5 (2x 4bit latch) D/A converts to output RIT voltage to the PLL.
PLL	O4 - O7	R15	IC4 (O4 - O7) outputs PLL data (BCD) and IC4 (R15) outputs latching pulse to set dividing ratio of programmable divider.
DISPLAY	O0 - O3	R7, R8	IC4 (O0 - O3) outputs display data (BCD) to LCD driver. IC4 (R7, R8) is connected to LCD driver CE and STD which reads and latches data.

TABLE (3) OTHER CPU COMMANDS

ITEM	OUT/IN	DETAILS OF COMMAND
VFO, FUNC sw.	RO - NC	Commands VFO mode for dialing.
M-CH, "	RO - K1	Commands memory dialing with memory number display
M-FR, "	RO - K2	Commands memory dialing with frequency displayed
CALL, "	RO - K4	Commands CALL memory operation
A+B, MEMO sw.	R1 - K2	Selects memories 1 through 10
A, "	R1 - NC	Selects memories 1 through 5
B, "	R1 - K1	Selects memories 6 through 10
AxB, "	R1 - K4	Receive on memories 1 - 5, transmit 6 - 10
OPEN, SCAN sw.	R2 - K1	Directs OPEN mode scanning
HOLD, "	R2 - NC	Directs scanning to stop and hold (Scan off)
BUSY, "	R2 - K2	Dirests BUSY mode scanning
+,OFFSET sw.	R2 - K4	Directs 600KHz plus transmit offset
S, "	R2 - NC	Directs transmit on same frequency as receive
-, "	R2 - K8	Directs 600KHz minus transmit offset
WRITE, WR sw.	R3 - K4	Directs "write in" to memories and CALL channels
SPEED, SPD sw.	R3 - K4	Sets dial to 100KHz steps
RIT, RIT sw.	R3 - K8	Change dial to 1KHz steps, max. ±1 channel width.
REV, REV sw.	R3 - K2	Receive on transmit frequency.
TSTOP ALARM signal	R5 - APC R5 - ALARM,	Output whenever transmit frequency exceeds THFBE Output when frequency and memory reaches bottom and top frequencies.
SCN, scan sig.	R12 - SCN	Directs scan START and STOP.
T8, TX signal	R12 - K4	Advises CPU, "transmitting."
DIAL(UP)	R13 - K1	UP signal for dialing frequency or memory
DIAL(DOWN)	R13 - K2	DOWN signal for dialing frequency or memory
MIC(UP)	R13 - K4	UP signal from mike for dialing frequency or memory
MIC(DOWN)	R13 - K8	DOWN signal from mike for dialing frequency or memory

NC = no connection

CAUTION: These alignment instructions are for use by qualified engineers and technicians with access to precision test instruments, including a spectrum analyzer. Attempts by unqualified persons to service the unit may result in serious damage to the unit as well as voiding a warranty policy.

6.1 PLL UNIT

A. PLL LOCAL OSCILLATOR: - Connect spectrum analyzer to base of Q6. Adjust L10, L11 for peak output (f=128.63MHz)

B. VCO LOCK: - (Set dial to 143.000MHz) Connect spectrum analyzer to TP1 (f=132.300MHz). Connect VTVM to TP3, adjust L1 to obtain a reading of 1.3 volt. Adjust L6 for max on spectrum analyzer.

C. PLL INPUT: - Connect oscilloscope to TP2.
a. RX - Adjust L7, L10 and L11 for max. 1V/P-P minimum.
b. TX - Transmit. Adjust VR5 for maximum. (1V/P-P min.)

D. CALIBRATE FREQUENCY: - (Set dial to 144.000, connect frequency counter to TP1.)
a. RX - Adjust VR4 so counter reads 133.300.
b. TX - Transmit. Adjust VR2 for 133.30.

E. 2.5KHz CALIBRATION: - (Necessary only if transceiver operated with other than 10KHz steps such as 5KHz, 12.5KHz 15KHz, etc.) Set dial to 143.005, *144.0125 as per dial stepping, connect counter to TP1, transmit and adjust VR1 so counter reads 143.005, *144.0125.

F. RIT CALIBRATION: - (Connect frequency counter to TP1). Set dial to 144.009. Adjust VR3 so counter reads 133.309.

G. CONFIRM FREQUENCY STANDARD CALIBRATION: - Connect frequency counter to TP1. Set transceiver to low and top limit frequencies, transmit and confirm frequency is within 200Hz. If frequency is out of limit at top frequency adjust values of C45, C46 of 9MHz oscillator.

6.2 RECEIVER

A. 2ND LOCAL OSCILLATOR: - Connect frequency counter to pin 2 of IC-1(TK10420) taking care not to load down circuit. Confirm frequency within 200Hz of 10.245MHz.

B. RF AMPLIFIER: - Connect 146.000Mhz signal to antenna connector. Set transceiver to 146.000MHz. Connect VTVM to TP and adjust L4 through L11 to obtain maximum reading on VTVM. Repeat to obtain true maximum reading.

C. SIGNAL METER: - Set signal generator to 146.000 +20dB output. Set VR6 so all LEDs are lit. Reduce signal to 0dB and confirm at least 1 LED is lit.

D. DISCRIMINATOR: - Set signal generator to 146.000, +10dB output modulated by 1KHz withdeviation of ±3KHz. Connect VTVM to speaker terminals and adjust L11 for maximum.

E. SCAN CENTER DETECTOR: - Set dial to 146.000, signal generator or signal source accurately to 145.998 (146.000 - 2KHz). Connect VTVM to pin 13 of IC6(TC-4011). Rotate VR7 from extreme C.W. slowly until VTVM suddenly drops from 4 to 0V. Leave VR7 set at this position. Vary transceiver dial by one click and confirm VTVM reading returns to 4 volts.

F. CONFIRMATION OF SQUELCH SENSITIVITY: - Set squelch just above threshold. Connect signal generator to antenna connector and confirm squelch opens with a -10dB signal.

G. SINAD CHECK: - Set signal generator to 146.000, +26dB, 1KHz modulation with 3KHz deviation. Connect distortion meter to speaker terminals. Set transceiver volume to obtain a 1V reading on distortion meter. Reduce signal to -6dB and confirm THD is less than 10%.

6.3 TRANSMITTER

A. Connect power meter, dummy load, frequency counter and spectrum analyzer to antenna connector.

B. POWER AMPLIFIER: - Set VR4 (Hi) of main unit fully clockwise disabling APC. Transmit (Hi) and adjust VC1 and VC2 to obtain maximum output with minimum spurs.

C. MODULATOR: - Connect audio generator to pin 1 of microphone connector, J4. Connect FM linear detector to antenna connector.

a. Set audio generator to 1KHz, 25mV. Transmit and adjust VR2 to obtain ±5KHz deviation.

b. Set audio generator to 1KHz, 2.5mV output, transmit and set VR1 to obtain ±3.5KHz deviation.

D. CALIBRATION OF HI/LOW POWER: - Connect power meter and dummy load to antenna connector.

a. Set transceiver to LO. Transmit and adjust VR5 of main unit for 5 watts. (Do not set below 5).

b. Set to HI. Transmit and set VR4 for 25w.

NOTE: Always set LO before setting HI. HI should not be set above 25 watts.

E. TRANSMIT LEVEL METER: - Transmit with HI power and set VR1 on LED display PCB so all LED's light up. Next transmit with LO and confirm less than 4 LED's are lit.

F. TONE MODULE ADJUSTMENT:

a. Connect FM Linear detector to transceiver output and counter to output of linear detector.

b. TONE-2033A - Set TONE on and transmit. Set VR1 of tone PCB so counter reads 103.5Hz (or desired frequency.) Next set VR3 of Main Unit for deviation of about ±500Hz. Frequency can be varied approximately 78 - 220Hz with existing constants. A lower or higher frequency is possible by adding or reducing values of C1 and R2

c. TONE-2033E - This module provides a tone-burst of about 1 second at 1750Hz. Ground collector of Q2 in order to obtain continuous tone. Confirm frequency is 1750Hz. Adjust VR3 of Main Unit so deviation is about ±2.5KHz.

7.0 OTHER MISCELLANEOUS INFORMATION

7.1 MANUAL TONE OPERATION USING TONE-2033E

Where manual 1750Hz tone repeator accessing is needed make the following changes:

a. Short circuit C4 (10mfd) of the tone module.

b. Transfer tone switch PTT wire to next terminal.

7.2 CHANGING VFO TO "ENDLESS" OPERATION:

The VFO is programmed ex-factory to stop at the low and high band edges. To change to "endless" operation add diode D21(EDLS) in initialization module, INT-2033. As soon as the VFO dial is moved one click beyond the high or low limits VFO will jump to the other limit and continue increasing or decreasing operating frequency respectively.

7.3 MEMORY BACK-UP BATTERY:

All memories (and the VFO) are backed up using the internal NICAD battery with a charging circuit. When the transceiver is not used for extended periods it is recommended the battery be removed in order to prevent possible damage to the printed circuit board.

A completely discharged battery can be recharged by leaving the transceiver connected to a power source and the power switched left "ON" for a few hours.

7.4 CIRCUIT DIAGRAM FOR TM-2 AND DM-100 MICROPHONES

Circuits are as shown below. The microphone connectors are shown as viewed from the front of the transceiver.

7.5 SCAN RESUME DELAY

An approximate 3 sec. delay has been built in to the SCAN resume of units supplied to some countries. This delay can be eliminated by removing the 2.2 mfd. electrolytic capacitor connected between pins 6 and 7 of IC6 of the CONTROL unit (C60).

Where this feature is not built in and is desired, connect a 2.2 mfd., 16 V, electrolytic capacitor between pins 6, (+), and 7, (-), of IC-6 of the CONTROL UNIT.

SPECIFICATIONS

1. GENERAL

Semi-conductors:	FET-8, TR-12, IC-19 & DIODES-59
VFO steps spacing:	5KHz, *12.5, (100KHz, Speed switch on), "wrap-around"
Memories:	11 (A=1-5, B=6-10 plus "CALL")
Band scanning:	Programmable (Scans between memory 5 & 10)
Band scan steps:	Same as VFO steps
Memory scanning:	A+B=1-10, A=1-5, B=6-10, AxB=1-5
Type of emission:	F3
Antenna impedance:	50 ohms nominal, unbalanced feed
Supply voltage/current:	13.8 ±15%
Current consumption:	RCV: standby, .3A, max vol., .8A TX: 6.0A (25w), 2.5A (5w)
Operating temperature:	-10 - 60 deg. C.
Dimensions:	55h x 162w x 182d mm. (body only)
Weight:	1.7kg (body only), 2.4 (shipping weight)
Shipping dimensions:	100h x 210w x 320d mm.

2. TRANSMITTER

Frequency range:	142.005 - 148.995MHz (*144.0125 - 149.995 MHz)
Output power:	25w (High) 5w (Low)
Modulation:	Variable reactance frequency modulation
Maximum deviation:	±5KHz
Spurious emissions:	Better than 60dB down
Repeator offset:	±600KHz
Repeator tone:	103.5Hz (adjustable), (E 1750Hz, crystal controlled)

3. RECEIVER

Frequency range:	142.000 - 148.995MHz (*144.000 - 149.995 MHz)
Receiver type:	Double superheterodyne
IF:	First 10.7MHz, second 455KHz
Sensitivity:	S/N ratio better than 35dB, 1uV, SINAD better than 12dB with .2uV input
Squelch sensitivity:	Better than .15uV
Bandwidth:	±5KHz/-6dB
Selectivity:	±12.5KHz/-60dB
Image ratio:	More than 70dB
Audio output:	More than 2w, 8 ohm load, THD 10%
RIT (Rec. incr. tune)	±1KHz steps, max one VFO step
Reverse:	Receive on transmit frequency

4. STANDARD ACCESSORIES INCLUDED

Microphone:	500 ohm, TM-2, tone encoder microphone with up/down buttons. (*DM-100 up/down microphone)		
Power cable assembly:	1	piece,	with 7A cartridge fuse
Spare fuse:	1	"	7A
External speaker plug:	1	"	miniature phone plug type
Mounting bracket:	1	"	
Screws, etc:	4	"	4 x 12mm self tapping screw
	4	"	plain washer
	1	"	microphone mounting clip
	1	"	instruction manual
	1	"	circuit diagram, folded

NOTE: A receiver spur will be encountered at 144.000MHz (Harmonic of 9MHz standard frequency.)

7.0 OTHER MISCELLANEOUS INFORMATION

C-MOS MICRO-PROCESSOR CONTROLLED

DIGITAL PHASE LOCKED SYNTHESIZER

8.20.81

2m VHF FM TRANSCEIVER

MODEL FM-2033

INSTRUCTION MANUAL

KDK KYOKUTO DENSHI CO., LTD.
21-25, 6 chome, Honcho, Nakano-ku, Tokyo 164, Japan

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8. SPECIFICATIONS, FM-2033 ....(13)

1. GENERAL FEATURES

The FM-2033 continues the KDK tradition of obtaining maximum operating features while retaining ease of operation, all in a small front panel and overall package size. The KDK design team achieved this by calling on their many years of experience in designing compact, VHF, mobile transceivers. The maximum use of multi-functional controls with co-axial knobs rather than a profusion of push buttons, and, in-house developed microprocessor programming provides a unique control system stressing "eyes-on-the-road" operations to enhance driving safety.

NOTE: This manual is written for the (A) version of the FM-2033. Where information differs for the (E) version sold in most European countries, information is added following an asterisk "".*

1. USER PROGRAMMABLE FUNCTIONS

Basic operating parameters can be re-set by the user by changing diodes located on a compact, plug-in, INITIALIZATION module. These are:

a. Dialing steps, 2.5 - 40KHz. Set at factory to 5KHz, *12.5KHz. (In multiples of 2.5KHz.)

b. Low frequency band edge (LFBE). Lowest frequency for transmit and receive. Can be set 142.00 - 155.00MHz. Set at factory to 142.00MHz, *144.00MHz.

c. Transmit high frequency band edge (THFBE). Highest transmit frequency. NOTE: Actual highest frequency is one step below limit set by THFBE mattrix. Can be set 142.00 - 155.00MHz. Set at factory to 150.00MHz, *146.00MHz.

d. Receive high frequency band edge (HFBE). Can be set 142.00 - 155.00MHz. Set at factory to 150.00MHz, *146.00MHz.

e. Offset frequency (for ± offset mode). 100KHz - 1.6MHz. In multiples of 100KHz. Set at factory to 600KHz.

f. Programmable DIAL EDGE mode. Dial operation mode at LFBE and HFBE can be set for "wrap-around" or "non-wrap" mode. Set at factory to "non-wrap" mode.

2. SPEED BUTTON

Speeds up dialing rate to 100KHz for rapid dialing to a widely separated frequency.

3. RIT (Receiver incremental tuning)

A digital RIT to shift receiver only in 1KHz steps. Max shift ± 1 dialing step. Operates in all modes; VFO, MEMORY and CALL.

4. REVERSE BUTTON (DIAL KNOB)

Push on dial knob to monitor duplex transmit channels. Operates in ± offset and AxB duplex modes. Also, RIT.

5. PROGRAMMABLE BAND SCANNING

Band scanning limits are frequencies written in to memory channels #5 and #10. Any portion or all of total frequency coverage can be selected. Set at factory to 144.500 and 148.500MHz, *145.500MHz.

6. TWO MODE SCANNING

Scanning in busy and open modes permits maintaining watch on busy channels as well as searching for vacant channels.

7. ELEVEN MEMORY CHANNELS

CALL memory plus 10 memory channels. Memory channels in two groups A and B. Groups A and B may be scanned separately or in total as set by memory mode switch. In AxB mode memory channels 1 - 5 are set for receiving and transmitting on corresponding channel 6 - 10. Permits memory of 5 non-standard offset frequency pairs.

MEMORY information includes transmit offset +, - or simplex as set by memory mode switch.

8. INTERNAL MEMORY BACK UP NICAD BATTERY

All memory channels and dial frequency data retained by internal back-up NICAD battery. The battery is automatically charged during operation of transceiver. Memory contents are retained even if the transceiver is disconnected from power source.

9. LCD FIVE DIGIT DISPLAY

Front panel LCD display for for good visibility in bright sunlight. Five digit display for indication down to 100Hz digit providing full read-out of 12.5KHz channel spacing frequencies.

10. TWO MODES OF MEMORY CHANNEL INDICATION

Memory channel number, or frequency, as selected by function switch.

11. CALL CHANNEL

Extra memory for storing frequently used frequencies. Instant recall by a flick of function switch. Stored frequency can be changed by dialing up new frequency, setting function switch to CALL, and pushing WRITE switch.

12. INTERNAL PLUG IN TONE OSCILLATOR

Switched on by pushing TONE button. 2033A - CTCSS encoder (Tunable, set at 103.5Hz ex-factory.) 2033E - 1750Hz crystal controlled tone burst. Can be set to provide manual controlled continuous tone. (See 7.1, page 12.

2. OPERATING CONTROLS AND INSTALLATION

2.1 OPERATING CONTROLS AND FUNCTIONS

This section describes functions of various knobs, switches, indicators and connectors on front and rear panels of the FM-2033. Photographs of panels are numbered identically with the paragraphs.

(1) FUNCTION SWITCH

Switches function of DIAL, (2).

VFO	Dial knob (2) selects frequency. (Dialing)
M-CH	Dial knob selects memories. Display (4) shows memory numbers.
M-FR	Dial knob selects memories. Display shows memory frequencies.
CALL	Call channel selected and dial disengaged.

Electronic alarm beeps at lowest and highest frequency, lowest and highest memories, also upon reaching channel edge for RIT.

(2) DIAL KNOB (AND REVERSE SWITCH)

Knob dials frequencies or memories as selected by FUNCTION switch (1) and RIT button:

a. In 5KHz steps, *12.5KHz
b. In 100Khz steps when SPEED, (17), engaged.
c. 1KHz steps, receiver only, when RIT, (16), engaged.

REV switch when pushed. Reverses receive and transmit frequencies for offset and RIT (for both the ± offset and AxB offset modes.)

(3) SCAN SWITCH

BUSY: Scanning starts. Stops upon reaching channel in use. Resumes soon as channel clears. To resume scanning while signal continues, step up one channel using dial knob or microphone UP button.

HOLD: Center, scanning "off" position for manual control.

OPEN: Scan starts. Stops upon reaching vacant channel. Resumes as soon as signal appears on channel. To resume scanning while channel continues vacant, step up one channel using dial knob or microphone UP button.

NOTE: In units supplied to certain countries, a 3 second delay has been built in to SCAN RESUME. In such units, the OPEN scan feature is inoperative. (See paragraph 7.5, page 12)

Type of scan set by FUNCTION SWITCH, (1), as follows:

VFO: Band scan. Scan limits are frequencies set in memories 5 and 10. Scans between these two freq. Band scan increments are same as dialing steps.

M-CH: Memory scan. DISPLAY (4), shows memory no.
SHOWS CHANNEL # ONLY

M-FR: Memory scan. DISPLAY (4), shows memory freq.

SCAN SKIP: In memory scanning, unwanted channels may be skipped to speed up scan repetition rate. Store lower band edge frequency in memory to be skipped. For example 142.000, *144.000.

(4) DISPLAY LCD

Shows frequencies in five digits in DIAL, M-FR and CALL positions of FUNCTION switch (1). Shows memory number in M-CH position. (Changes to show frequency when a new frequency is written in to memory and returns to memory number as soon as WRITE button is released.)

(5) RECEIVE LED

Lights up while signal being received. (Receiver unsquelched.)

(6) TRANSMIT LED

Lights up during transmitting. (Lights up at band edges but transmitter inoperative to prevent an out-of-band transmission.)

(7) SIGNAL/POWER INDICATOR

Dual function bar type LED meter to show relative strength of incoming signal AND transmitter output.

(8) MICROPHONE CONNECTOR

Connector for microphone. Includes 13.8 volt power source for KDK TM-2 tone encoder microphone. (DM-100 UP/DOWN microphone provided in some countries, in which case the TM-2 may be optionally available from distributor or dealor.)

(9) HIGH LOW BUTTON

Selects transmitter output power. HIGH, 25 watts; LOW, 5 watts. Both can be reset for intermediate values. Do not set at less than 5 watts.

(10) TONE BUTTON

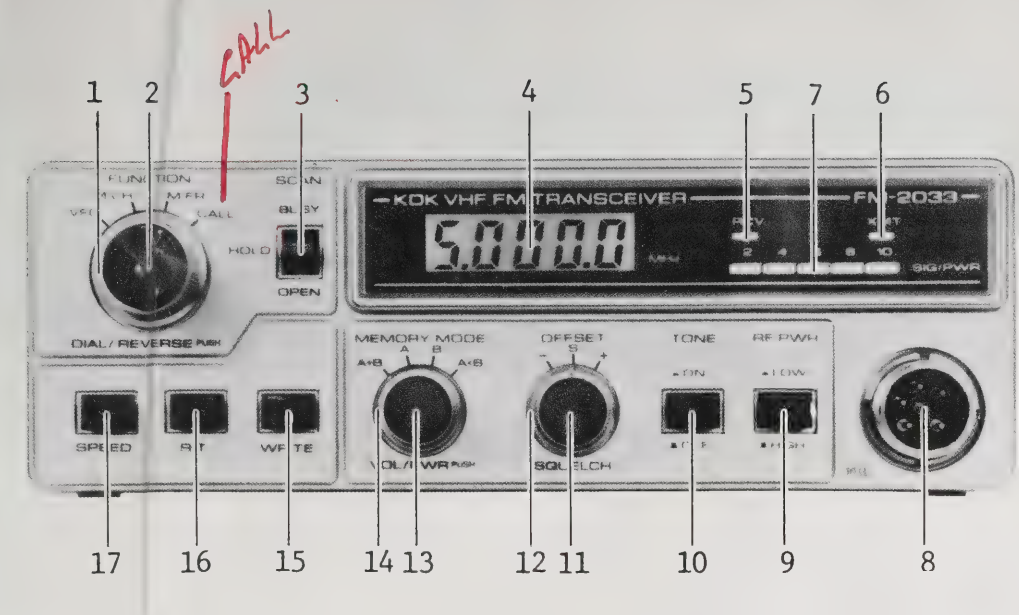
Selects tone for repeator use. Type of tone operation set by plug-in module. TONE-2033A: CTCSS - frequency varied by internal trim-pot. TONE-2033E: crystal controlled 1750HZ tone burst. (See page 12 for manual tone control.)

(11) SQUELCH CONTROL

Mutes receiver noises during no signal conditions. Should be set at point where noise is just squelched out when advanced in a CW direction from extreme CCW position.

(12) OFFSET SWITCH

S	Simplex. Transmit and receive on same freq.
+	Transmit 600KHz above receive frequency.



FRONT PANEL

- Transmit 600KHz below receive frequency.

DISPLAY (4), switches between receive and transmit frequency. Amount of offset re-programmable by changing diodes in INT-2033 module. If offset exceeds upper or lower band limits, display shows ----- as soon as P/T is keyed and cannot transmit.

(13) VOLUME/POWER CONTROL

Volume increases as knob turned in a CW direction.

Push knob to turn power on. Push again to turn off.

(14) MEMORY MODE SWITCH

A+B	Selects all memories, 1 through 10.
A	Selects memories 1 through 5
B	Selects memories 6 through 10
AxB	Duplex using memories. Receive on memories 1 through 5 and transmit on corresponding 6 through 10. DISPLAY (4), switches between receive and transmit frequencies.

(15) WRITE BUTTON:

Push to write desired frequency to CALL and memory channels.

PRIORITY WRITE-IN: Pushing this button while in VFO mode of function switch, will write dialed frequency in to memory #1. Suggest memory #1 be used for storage of frequencies to be used only temporarily.

(16) RIT (Receiver Incremental Tuning)

When engaged, DIAL (2) and UP/DOWN buttons (22) (23), shifts receiver in 1KHz steps. Operates in DIAL, M-FR and CALL functions. Maximum shift ± one dial step.

NOTE 1: When RIT engaged, RIT may be cleared and receiver returned to center by switching FUNCTION switch (1) to other position momentarily, then returning to original position.

NOTE 2: RIT must be disengaged in order to DIAL or select memories.

(17) SPEED SWITCH

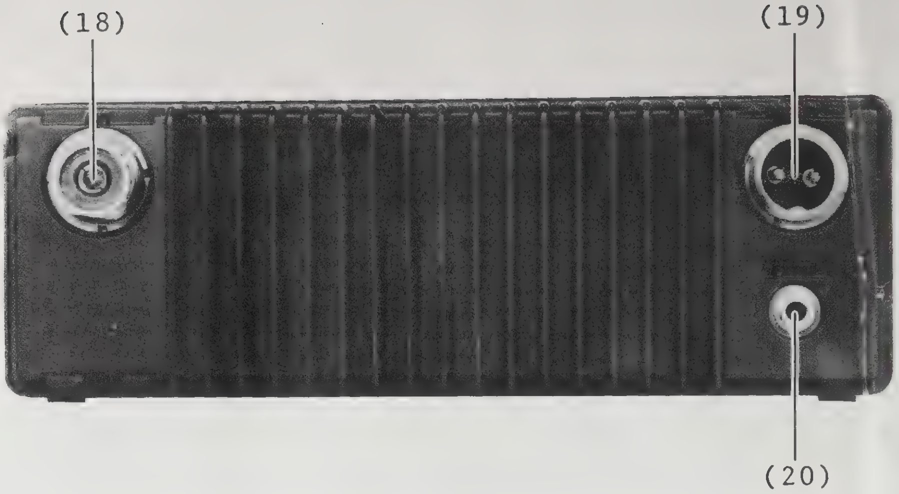
Increases dialing rate to 100KHz per step. Use for rapid dialing to a widely separated frequency. (This function inoperative during band scanning.)

(18) ANTENNA CONNECTOR

SO-239 type. Will accept both metric and inch threaded plugs.

(19) DC CONNECTOR

Receptacle for connecting DC 13.8 volts. Use cable supplied with transceiver. Connect red lead to positive and black lead to negative terminal. Use only 7A fuses.



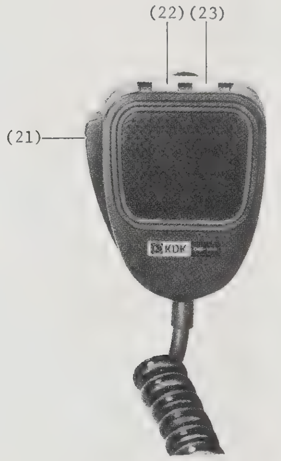
REAR PANEL

(20) EXTERNAL SPEAKER JACK

A mini plug to fit this jack is included as a standard accessory.

(21) P/T (Press to talk) SWITCH

Press to key transmitter.



DM-100 MICROPHONE

(22) DOWN BUTTON

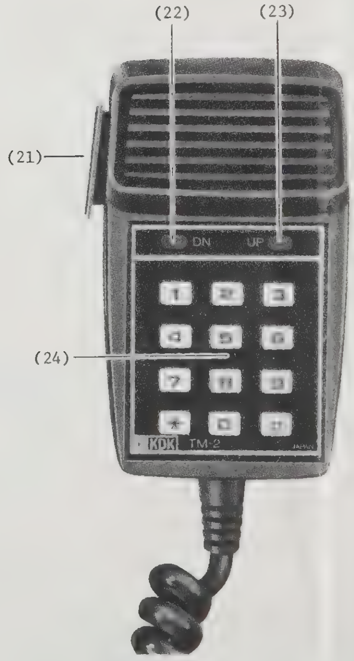
A momentary push will:

a. VFO: Lower frequency by one step.
b. M-CH: Select next lower memory. Also M-FR.
c. RIT: Lower frequency by 1KHz.

If button is held down, above action repeats, slowly at first and then faster, until button is released or maximum RIT shift is reached.

(23) UP BUTTON

Same action as down button except direction of change is upwards.



TM-2 TONE ENCODER MICROPHONE

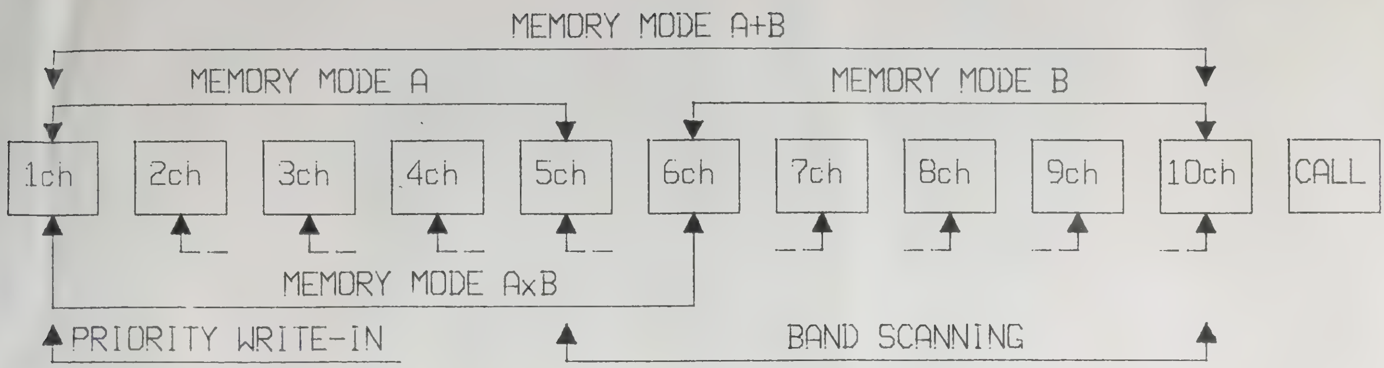
(24) TONE ENCODER BUTTONS

These buttons transmit standard telephone dialing tones. Frequencies are as shown below. Pushing buttons, keys transmitter and not necessary to hold down P/T switch, (20). Transmitter continues to be keyed for about .7 seconds after button released, permitting smooth key-in of a sequence of numbers.

LOW TONES HIGH TONES

	1209	1336	1447Hz
697	1	2	3
770	4	5	6
852	7	8	9
941	#	0	*

NOTE: Where DM-100 is standard microphone provided with the transceiver, the TM-2 may be optionally available from distributor or dealor.



FUNCTIONAL LAYOUT, MEMORIES

2.2 MEMORY CHANNEL RELATIONSHIPS

(1) CALL CHANNEL

Dial desired frequency. Set FUNCTION switch to CALL Push WRITE button.

(2) MEMORY CHANNELS

① Dial desired frequency. Set ② FUNCTION switch to M-CH and select desired memory. ③ Push WRITE button. ④ DISPLAY will change to selected frequency signifying the frequency has been written in. As soon as write button is released, display will return to showing memory channel number.

(3) BAND SCAN LIMITS

Desired upper and lower limits for band scanning should be written in to memories #5 and 10. NOTE: When designating the highest frequency as the upper limit, use frequency 1 step down from the HFBE, i.e., if HFBE=149.000 then use 148.995MHz, *145.9875MHz.

(4) SCAN SKIP, MEMORY SCANNING

Reducing number of channels scanned increases relative speed of scanning. Thus scanning in the A or B mode is twice as fast as scanning in the A+B mode. Speed can be further increased by removing unnecessary channels from scanning sequence. This is accomplished by writing in the LFBE frequency to the unwanted memory, i.e., 142.000, *144.000MHz.

(5) ENTERING OFFSET MODE TO MEMORIES

Select desired frequency in VFO mode. Set FUNCTION switch to M-CH and select desired memory channel. Set mode switch to Simplex, + or - as desired. Push WRITE switch.

(6) ENTERING OFFSET MODE TO CALL MEMORY

Select desired frequency in VFO mode. Set FUNCTION switch to CALL. Set mode switch to Simplex, + or - as desired. Push WRITE switch.

2.3 MOBILE INSTALLATION

(1) Install mounting bracket included with unit under dashboard or convenient location using four, 4 x 12mm, self tapping screws located in samll plastic bag in microphone carton. A 3mm hole should be pre-drilled to use these self tapping screws.

(2) Mount the transceiver in bracket using two black thumbscrews provided. Select best angle of installation for easy operation. The bracket, while very simple in design, is very flexible to match various mounting situations.

(3) Connect antenna feed cable to connector on rear panel. The SO-239 type connctor will accept both metric or inch threaded plugs.

(4) Connect red/black cable packed in microphone carton to power source. Red lead is + and black - (negative ground). These should be connected to point with lowest possible impedance such as directly to the battery, or as a 2nd choice, the fuse box.

(5) Plug mike into connector, (8) on front panel.

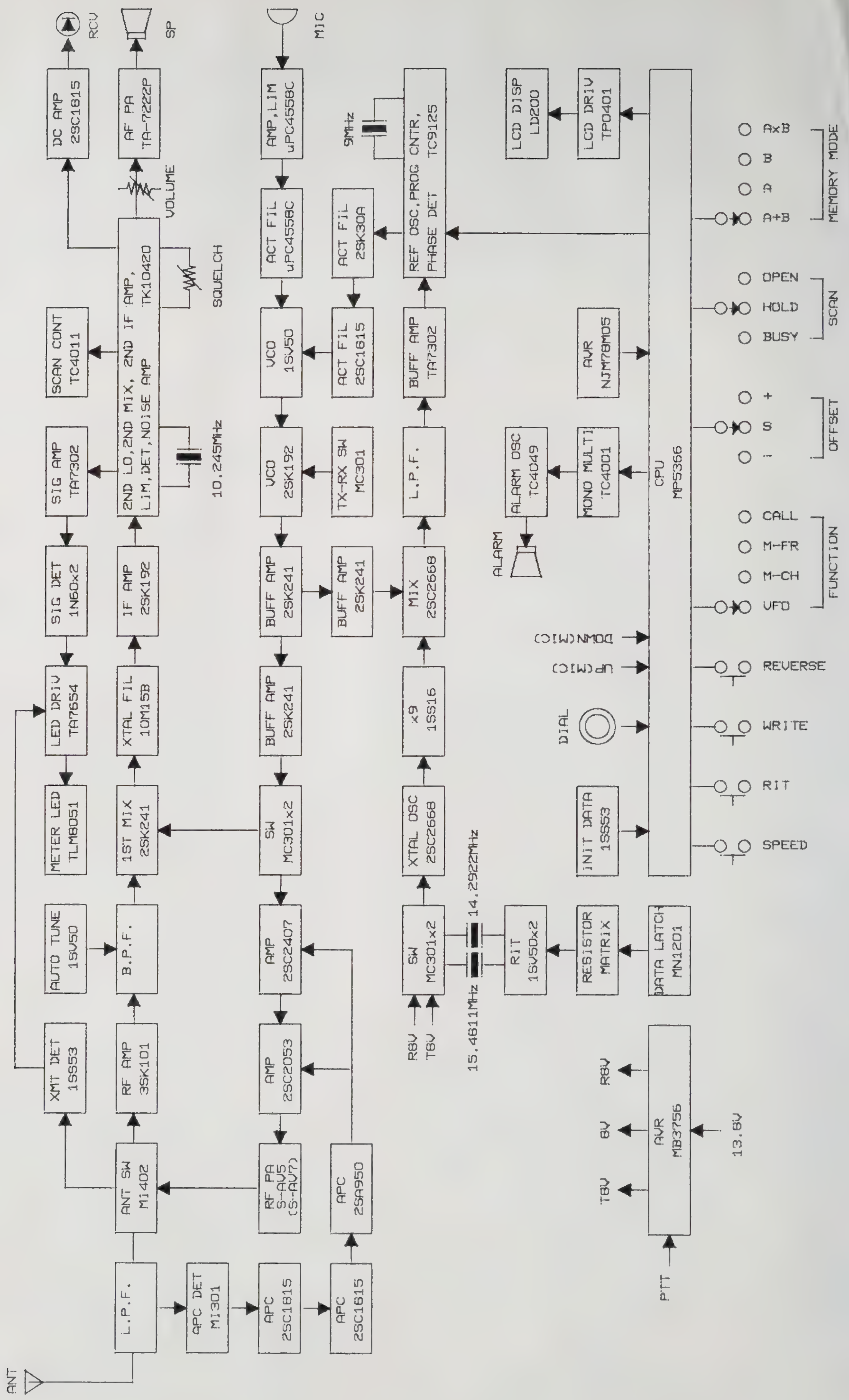
2.4 FIXED INSTALLATION

(1) Rubber feet are provided on the bottom of unit. It is frequently easier to operate if the unit is placed so front panel is tilted upwards. An extra mobile bracket can be used for this as shown in the cover photograph.

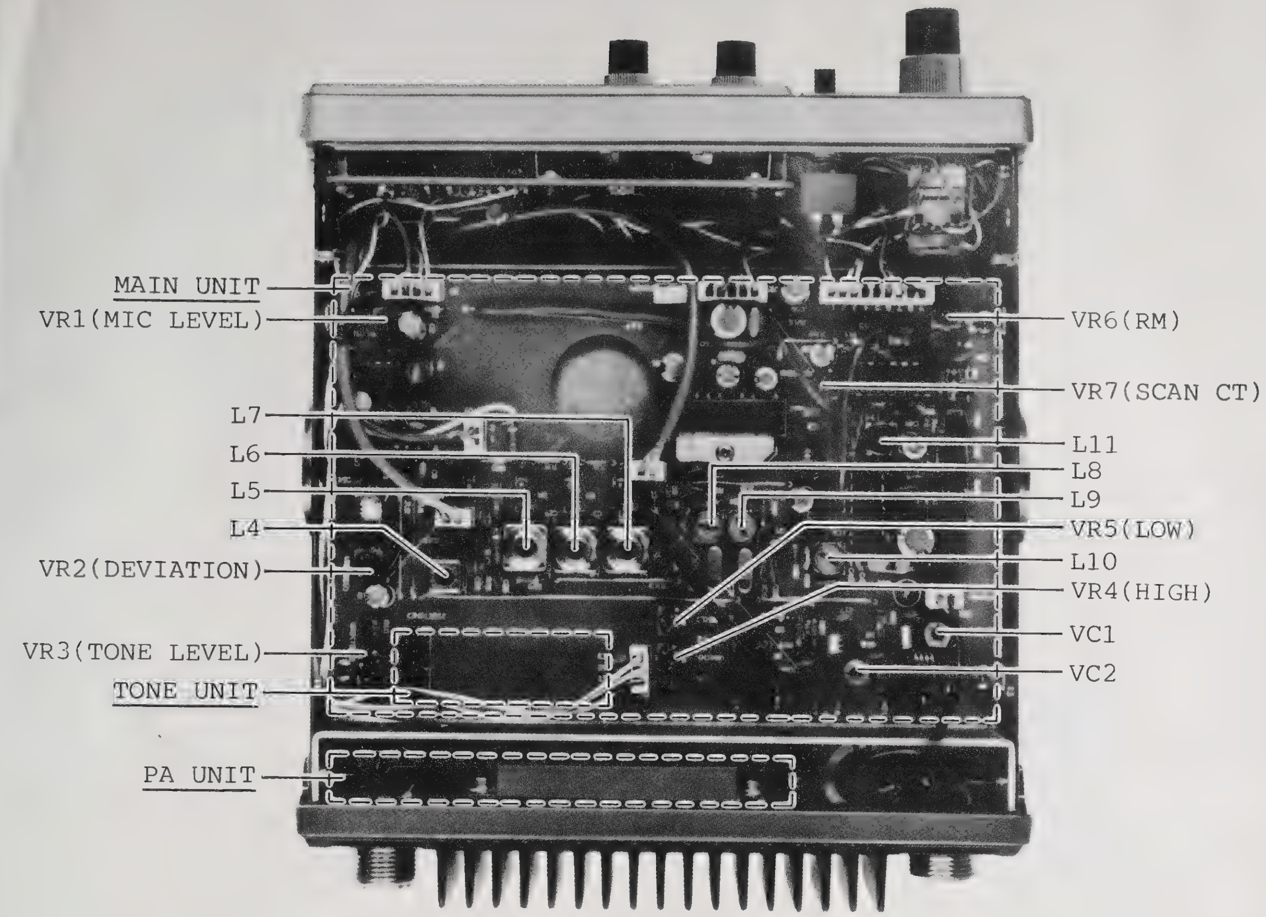
(2) A good battery or regulated power supply of sufficient capacity should be used. A power supply of insuficient capacity may result in damaging the transceiver.

(3) For other information, refer to paragraphs 3, 4 and 5 of the preceding section.

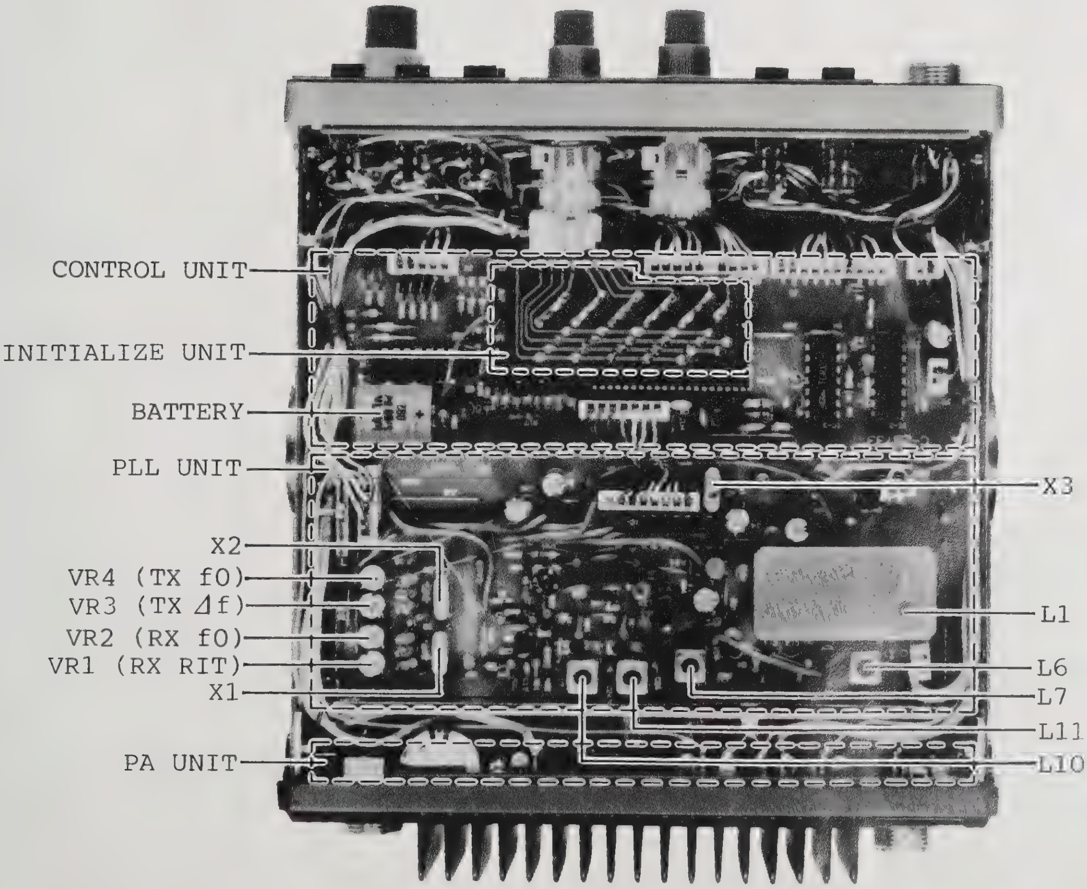
3. BLOCK DIAGRAM



4. INTERNAL VIEWS



TOP VIEW SHOWING MAIN UNIT WITH 2033A TONE MODULE



BOTTOM VIEW SHOWING PLL AND CONTROL UNITS

5. CIRCUIT DESCRIPTION

5.1 RECEIVER

RF AMPLIFIER: -- Signal from antenna connector is fed through low pass filter, L6, L5, L4, C20, C17, C16 and C15 and is applied to connector J5 of MAIN unit. Signal is then amplified by MOS-FET Q6. It then passes through a 3-stage electronic auto tuned circuit L5 through L7 and D4 through D6. This circuit keeps sensitivity constant over the wide band coverage, also keeps out unwanted signals. Signal is then applied to gate of Q2.

1ST MIXER: -- The 130MHz band injection voltage from the VCO is input through connector J7 and is applied to source of mixer, Q7. The 10.7MHz output from the mixer is extracted from drain of Q7.

1ST IF AMPLIFIER: -- The converted signal is passed through a combination of two monolithic crystal filters, XF, with a selectivity of ±15KHz/3dB, and LC filtering, L8 and L9, to further attenuate adjacent channel interference. It is then amplified by Q8, and passed on to next stage, IC4.

2ND MIXER THROUGH DETECTOR: -- IC4 is a one chip multi-purpose LSI. It contains the 2nd mixer, 2nd local oscillator, IF amplifier, limiter, quadrature detector, squelch noise amplifier and muting circuitry. Very few external components are needed improving reliability. The 1st IF signal inputs to IC3 from pin 16 and is mixed in the IC with the 2nd local oscillator signal. The 2nd L.O. is controlled by crystal X, connected between pins 1 and 2. A converted 455KHz signal appears at pin 3 and is fed through ceramic filter, CF, with a pass-band of +-6KHz/3dB. It re-enters IC3 through pin 5 and is amplified and limited. Treated signal appears at pins 7 and 8 and is demodulated by the combination of internal LSI circuitry and quadrature coil, L9. Demodulated audio appears at pin 9 of IC4.

AUDIO AMPLIFIER: -- Audio, from pin 9 of IC4, is applied to pin 7 of IC1, and passes through the de-emphasis circuit in IC1. It re-appears at pin 8 of IC1 from where it is taken to front panel volume control. It is set to proper level by the control and then connected to pin 4 of IC7. Output from IC2 is taken from pin 9 and connected to the speaker via the external speaker jack.

SQUELCH CIRCUITRY: -- The demodulated signal from pin 9 of IC4 is connected to pin 7 of IC3 from where it is connected to the internal low-pass filter and squelch control circuitry. Front panel squelch control is connected to pins 1 and 4 of IC3 and is used to set squelch threshold levels.

"S" METER CIRCUITRY: -- The signal for the meter is taken from output side of ceramic filter, CF, and applied to pin 1 of IC5, where it is amplified and then ouput from pin 6. It is rectified in a voltage doubler circuit, D10 and D9, set for meter sensivity by VR6 and is connected to pin 3 of IC1 of the DISPLAY unit. This signal is A/D converted by IC3 which drives the LED bar-meter, D3.

RCV LED CIRCUIT: - The squelch muting signal at pin 13 of IC4 of the main unit switches transistor Q9 to drive the RCV LED, D1, of the DISPLAY unit. LED lights up when squelch opens.

SCAN CENTER DETECTOR CIRCUIT: - This transceiver is designed to operate on channel steps as close as 2.5KHz. If SCAN control relied solely on incoming signal, scanning may stop prematurely before reaching center of channal. The center detector prevents this in busy mode scanning. Output from detector and RCV LED are fed to an "AND" circuit so scanning halts only at center of channel. A signal, (4V ±1V), is obtained from pin 9 of IC4 and is connected to pins 1 and 2 of IC6. IC6 outputs an inverted signal at pin 3 only when its input is 4V ±1V. This is connected to pin 13 of the BUSY control. Output from control is at pin 11 and is connected to pin 9 in an AND circuit with the RCV signal applied to pin 8. Output appears at pin 10 only when both pins 9 and 8 are high which is used to control scanning. Center detector is not used in OPEN scanning. Pin 12 is set to L level, so scanning is controlled only by the RCV LED signal.

5.2 TRANSMITTER

MICROPHONE AMPLIFIER: - Audio signals from the mike are adjusted for level by control VR1 on MAIN unit. It is amplified by IC1 and shaped by pre-emphasis circuit and limiter using active filter, IC2. VR2 sets deviation. This audio is connected to PLL unit through connector J6 and is applied to D60 of PLL to frequency modulate the VCO.

TRANSMITTER EXCITER STAGES: -- The VCO signal from the PLL is input through J7 and after switching by D7 is amplified by transisters Q4 and Q5 to about .5 watts. This is output through connector, J9.

POWER AMPLIFIER: -- The output of the MAIN unit from J9 is applied to IC1 of the rear panel power amplifier unit and amplified to more than 25 watts. Its output passes through antenna switching diode D1 and then through the low pass filter, L4 - L6, C15 - C17 and C20 to remove harmonics. It is then conncted to the antenna connector.

APC (AUTO POWER CONTROL): - A portion of the output is sampled by diode D4 which provides a rectified output from pin 10 to J8-1 of Main Unit. Signal is fed through the Hi and Lo power controls VR4 and VR5 and is then amplified by transisters Q1 through Q3. The amplified output controls supply voltage to transistors Q4 and Q5 to achieve power control.

Transmitter stop signal from CPU is applied to APC through J8-3 and lowers voltage supplied to Q4 and Q5 effectively stopping transmission.

5.3 PLL SECTION

VCO CIRCUIT: -- The VCO circuit is formed by L1, D1 and Q1. It is set to the 130MHz band for receiving. D2 sets it to the 140MHz band for transmitting. VCO output is bufferred by Q2, Q3, and is output from J1. VCO frequency is controlled by applying a DC voltage to varicap diode D1 locking VCO in to PLL.

PLL LOCAL OSCILLATOR AND MIXER: -- PLL L.O. is a VXO, D4, X2, and Q5. Frequency is set by varying voltage on D4 by control, VR4. RIT voltage from computor via J9-3 is applied to D4 through VR3 and varies f0 in 1KHz steps.

For transmitting, VXO is X1, D3, Q5. Frequency is set by varying bias on D3 by VR2. A fine tune control voltage from CPU (for 2.5KHz and 5KHz steps) via J9-3 is set by VR1 and applied to D3 to fine tune the local oscillator.

Output of Q5 is multiplied by 9 using Schottky barrier diode D7 and is applied to mixer, Q6, through band-pass filter, L10 and L11. Output from VCO is bufferred by Q4 and applied to Q6 to obtain a converted output of 3.67 - 9.67. Unwanted spurs are removed by low-pass filter L12, C30 and C31. Output from filter is amplified by IC1 and applied to pin 9 of IC2 as the phase comparator signal.

PLL CIRCUITRY: -- IC2 is a one-chip LSI containing the standard frequency oscillator and divider, phase comparator, programmable divider and data latch. The standard is controlled by crystal X3 connected between pins 2 and 3. Signal is divided by 900 as set by data applied to pins 4 - 8, to obtain a 10KHz standard. Converted output from pin 6 is applied to pin 9 and is divided according to data from CPU applied to pins 4 through 8. Divided signal is fed to phase comparator with 10KHz standard. A pulse is output from pin 15 which relates to phase difference between the two signals. Pulse is converted to dc by active low pass filter Q8, Q9, and is used to control VCO frequency as well as receiver electronic tuning circuits. V oltage, TV (Tuning Voltage), is output via TP3. Pin 13 outputs an "H" level during PLL unlock and switches Q7 to lower the supply voltage on Q3 to stop output from the VCO.

5.4 CPU CONTROL SECTION

All control functions are centered around the CPU, MP-5366, with KDK in-house developed programming. Data inputs are K1 - K8 and L1 through L8. Time division outputs are R0 - R15, and decode outputs O0 - O7. Control functions are achieved by connecting various input and output terminals.

INITIALIZATION DATA FOR CPU: - Outputs R4, R7 - R11 are connected to input K1 - K8 by BCD coded diode mattrixes on initialize module to command various actions to CPU as tabulated in Table (1).

CPU DATA OUTPUT: -- See Table (2).

IN/OUT COMMANDS: - See Table (3).

INTERNAL MEMORY BACKUP NICAD: - As soon as power is switched off, 5V supply starts to drop. Q2 is cutoff and voltage across R12 is connected to K8 through D5 to advise CPU of power switch off. CPU switches all outputs to high impedance. As supply voltage drops, Q1 is cutoff and CPU HLT terminal switches to H level. CPU is backed-up by internal NICAD and changes to low power consumption mode.

ALARM SIGNAL CIRCUIT: -- The alarm signal is output from CPU terminal R6. These pulses are widened by one shot multivibrator IC3-3, IC3-4 and switches multivibrator IC3-1, IC3-2 to generate a 4KHz signal. This is bufferred by IC2-3 to drive the alarm beeper.

LCD CIRCUITRY: - 4bit parallel data from the CPU, STD, CE and the framing clock signals from IC2-1/IC2-2 are applied to LCD driver, TP0401 to dynamically drive the 5 digit LCD, LD-200.

TABLE (1) PROGRAM INITIALIZATION

ITEM	INPUT	OUTPUT	UNIT	MULTIPLIER	SET AT FACTORY
STEP	R11	K1 - K8	2.5KHz	x1 - 16(0)	x2, *x5 5, *12.5KHz
OFFSET	R10	K1 - K8	100KHz	x1 - 16(0)	x6 600KHz
THFE	R9	K1 - K8	1MHz	x1 - 16(0)	x9, *x6 150, *146MHz
HFE	R8	K1 - K8	1MHz	x1 - 16(0)	x9, *x6 150, *146MHz
LFE	R7	K1 - K8	1MHz	x1 - 16(0)	x3, *x4 142, *144MHz
UHF	R4	K4	-	Offset base frequency changed to 500KHz	
EDLS	R4	K2	-	Commands "wrap-around" dial mode	

* 2030 (E)

TABLE (2) DATA OUTPUT

ITEM	DATA	TIMING	ACTION
RIT	O4 - O7	R10, R11	IC4 (O4 - O7) outputs RIT data (BCD) and IC4 (R10, R11) outputs latching pulse. Resistor mattrix of IC5 (2x 4bit latch) D/A converts to output RIT voltage to the PLL.
PLL	O4 - O7	R15	IC4 (O4 - O7) outputs PLL data (BCD) and IC4 (R15) outputs latching pulse to set dividing ratio of programmable divider.
DISPLAY	O0 - O3	R7, R8	IC4 (O0 - O3) outputs display data (BCD) to LCD driver. IC4 (R7, R8) is connected to LCD driver CE and STD which reads and latches data.

TABLE (3) OTHER CPU COMMANDS

ITEM	OUT/IN	DETAILS OF COMMAND
VFO, FUNC sw.	RO - NC	Commands VFO mode for dialing.
M-CH, "	RO - K1	Commands memory dialing with memory number display
M-FR, "	RO - K2	Commands memory dialing with frequency displayed
CALL, "	RO - K4	Commands CALL memory operation
A+B, MEMO sw.	R1 - K2	Selects memories 1 through 10
A, "	R1 - NC	Selects memories 1 through 5
B, "	R1 - K1	Selects memories 6 through 10
AxB, "	R1 - K4	Receive on memories 1 - 5, transmit 6 - 10
OPEN, SCAN sw.	R2 - K1	Directs OPEN mode scanning
HOLD, "	R2 - NC	Directs scanning to stop and hold (Scan off)
BUSY, "	R2 - K2	Dirests BUSY mode scanning
+,OFFSET sw.	R2 - K4	Directs 600KHz plus transmit offset
S, "	R2 - NC	Directs transmit on same frequency as receive
-, "	R2 - K8	Directs 600KHz minus transmit offset
WRITE, WR sw.	R3 - K4	Directs "write in" to memories and CALL channels
SPEED, SPD sw.	R3 - K4	Sets dial to 100KHz steps
RIT, RIT sw.	R3 - K8	Change dial to 1KHz steps, max. ±1 channel width.
REV, REV sw.	R3 - K2	Receive on transmit frequency.
TSTOP ALARM signal	R5 - APC R5 - ALARM,	Output whenever transmit frequency exceeds THFBE Output when frequency and memory reaches bottom and top frequencies.
SCN, scan sig.	R12 - SCN	Directs scan START and STOP.
T8, TX signal	R12 - K4	Advises CPU, "transmitting."
DIAL(UP)	R13 - K1	UP signal for dialing frequency or memory
DIAL(DOWN)	R13 - K2	DOWN signal for dialing frequency or memory
MIC(UP)	R13 - K4	UP signal from mike for dialing frequency or memory
MIC(DOWN)	R13 - K8	DOWN signal from mike for dialing frequency or memory

NC = no connection

6.0 ALIGNMENT

CAUTION: These alignment instructions are for use by qualified engineers and technicians with access to precision test instruments, including a spectrum analyzer. Attempts by unqualified persons to service the unit may result in serious damage to the unit as well as voiding a warranty policy.

6.1 PLL UNIT

A. PLL LOCAL OSCILLATOR: - Connect spectrum analyzer to base of Q6. Adjust L10, L11 for peak output (f=128.63MHz)

B. VCO LOCK: - (Set dial to 143.000MHz) Connect spectrum analyzer to TP1 (f=132.300MHz). Connect VTVM to TP3, adjust L1 to obtain a reading of 1.3 volt. Adjust L6 for max on spectrum analyzer.

C. PLL INPUT: - Connect oscilloscope to TP2.
a. RX - Adjust L7, L10 and L11 for max. 1V/P-P minimum.
b. TX - Transmit. Adjust VR5 for maximum. (1V/P-P min.)

D. CALIBRATE FREQUENCY: - (Set dial to 144.000, connect frequency counter to TP1.)
a. RX - Adjust VR4 so counter reads 133.300.
b. TX - Transmit. Adjust VR2 for 133.30.

E. 2.5KHz CALIBRATION: - (Necessary only if transceiver operated with other than 10KHz steps such as 5KHz, 12.5KHz 15KHz, etc.) Set dial to 143.005, *144.0125 as per dial stepping, connect counter to TP1, transmit and adjust VR1 so counter reads 143.005, *144.0125.

F. RIT CALIBRATION: - (Connect frequency counter to TP1). Set dial to 144.009. Adjust VR3 so counter reads 133.309.

G. CONFIRM FREQUENCY STANDARD CALIBRATION: - Connect frequency counter to TP1. Set transceiver to low and top limit frequencies, transmit and confirm frequency is within 200Hz. If frequency is out of limit at top frequency adjust values of C45, C46 of 9MHz oscillator.

6.2 RECEIVER

A. 2ND LOCAL OSCILLATOR: - Connect frequency counter to pin 2 of IC-1(TK10420) taking care not to load down circuit. Confirm frequency within 200Hz of 10.245MHz.

B. RF AMPLIFIER: - Connect 146.000Mhz signal to antenna connector. Set transceiver to 146.000MHz. Connect VTVM to TP and adjust L4 through L11 to obtain maximum reading on VTVM. Repeat to obtain true maximum reading.

C. SIGNAL METER: - Set signal generator to 146.000 +20dB output. Set VR6 so all LEDs are lit. Reduce signal to OdB and confirm at least 1 LED is lit.

D. DISCRIMINATOR: - Set signal generator to 146.000, +10dB output modulated by 1KHz withdeviation of ±3KHz. Connect VTVM to speaker terminals and adjust L11 for maximum.

E. SCAN CENTER DETECTOR: - Set dial to 146.000, signal generator or signal source accurately to 145.998 (146.000 - 2KHz). Connect VTVM to pin 13 of IC6(TC-4011). Rotate VR7 from extreme C.W. slowly until VTVM suddenly drops from 4 to 0V. Leave VR7 set at this position. Vary transceiver dial by one click and confirm VTVM reading returns to 4 volts.

F. CONFIRMATION OF SQUELCH SENSITIVITY: - Set squelch just above threshold. Connect signal generator to antenna connector and confirm squelch opens with a -10dB signal.

G. SINAD CHECK: - Set signal generator to 146.000, +26dB, 1KHz modulation with 3KHz deviation. Connect distortion meter to speaker terminals. Set transceiver volume to obtain a 1V reading on distortion meter. Reduce signal to -6dB and confirm THD is less than 10%.

6.3 TRANSMITTER

A. Connect power meter, dummy load, frequency counter and spectrum analyzer to antenna connector.

B. POWER AMPLIFIER: - Set VR4 (Hi) of main unit fully clockwise disabling APC. Transmit (Hi) and adjust VC1 and VC2 to obtain maximum output with minimum spurs.

C. MODULATOR: - Connect audio generator to pin 1 of microphone connector, J4. Connect FM linear detector to antenna connector.

a. Set audio generator to 1KHz, 25mV. Transmit and adjust VR2 to obtain ±5KHz deviation.

b. Set audio generator to 1KHz, 2.5mV output, transmit and set VR1 to obtain ±3.5KHz deviation.

D. CALIBRATION OF HI/LOW POWER: - Connect power meter and dummy load to antenna connector.

a. Set transceiver to LO. Transmit and adjust VR5 of main unit for 5 watts. (Do not set below 5).

b. Set to HI. Transmit and set VR4 for 25w.

NOTE: Always set LO before setting HI. HI should not be set above 25 watts.

E. TRANSMIT LEVEL METER: - Transmit with HI power and set VR1 on LED display PCB so all LED's light up. Next transmit with LO and confirm less than 4 LED's are lit.

F. TONE MODULE ADJUSTMENT:

a. Connect FM Linear detector to transceiver output and counter to output of linear detector.

b. TONE-2033A - Set TONE on and transmit. Set VR1 of tone PCB so counter reads 103.5Hz (or desired frequency.) Next set VR3 of Main Unit for deviation of about ±500Hz. Frequency can be varied approximately 78 - 220Hz with existing constants. A lower or higher frequency is possible by adding or reducing values of C1 and R2

c. TONE-2033E - This module provides a tone-burst of about 1 second at 1750Hz. Ground collector of Q2 in order to obtain continuous tone. Confirm frequency is 1750Hz. Adjust VR3 of Main Unit so deviation is about ±2.5KHz.

7.0 OTHER MISCELLANEOUS INFORMATION

7.1 MANUAL TONE OPERATION USING TONE-2033E

Where manual 1750Hz tone repeator accessing is needed make the following changes:

a. Short circuit C4 (10mfd) of the tone module.

b. Transfer tone switch PTT wire to next terminal.

7.2 CHANGING VFO TO "ENDLESS" OPERATION:

The VFO is programmed ex-factory to stop at the low and high band edges. To change to "endless" operation add diode D21(EDLS) in initialization module, INT-2033. As soon as the VFO dial is moved one click beyond the high or low limits VFO will jump to the other limit and continue increasing or decreasing operating frequency respectively.

7.3 MEMORY BACK-UP BATTERY:

All memories (and the VFO) are backed up using the internal NICAD battery with a charging circuit. When the transceiver is not used for extended periods it is recommended the battery be removed in order to prevent possible damage to the printed circuit board.

A completely discharged battery can be recharged by leaving the transceiver connected to a power source and the power switched left "ON" for a few hours.

7.4 CIRCUIT DIAGRAM FOR TM-2 AND DM-100 MICROPHONES

Circuits are as shown below. The microphone connectors are shown as viewed from the front of the transceiver.

7.5 SCAN RESUME DELAY

An approximate 3 sec. delay has been built in to the SCAN resume of units supplied to some countries. This delay can be eliminated by removing the 2.2 mfd. electrolytic capacitor connected between pins 6 and 7 of IC6 of the CONTROL unit (C60).

Where this feature is not built in and is desired, connect a 2.2 mfd., 16 V, electrolytic capacitor between pins 6, (+), and 7, (-), of IC-6 of the CONTROL UNIT.

8. SPECIFICATIONS -- FM-2033

1. GENERAL

Semi-conductors:	FET-8, TR-12, IC-19 & DIODES-59
VFO steps spacing:	5KHz, *12.5, (100KHz, Speed switch on), "wrap-around"
Memories:	11 (A=1-5, B=6-10 plus "CALL")
Band scanning:	Programmable (Scans between memory 5 & 10)
Band scan steps:	Same as VFO steps
Memory scanning:	A+B=1-10, A=1-5, B=6-10, AxB=1-5
Type of emission:	F3
Antenna impedance:	50 ohms nominal, unbalanced feed
Supply voltage/current:	13.8 ±15%
Current consumption:	RCV: standby, .3A, max vol., .8A TX: 6.0A (25w), 2.5A (5w)
Operating temperature:	-10 ~ 60 deg. C.
Dimensions:	55h x 162w x 182d mm. (body only)
Weight:	1.7kg (body only), 2.4 (shipping weight)
Shipping dimensions:	100h x 210w x 320d mm.

2. TRANSMITTER

Frequency range:	142.005 - 148.995MHz (*144.0125 - 149.995 MHz)
Output power:	25w (High) 5w (Low)
Modulation:	Variable reactance frequency modulation
Maximum deviation:	±5KHz
Spurious emissions:	Better than 60dB down
Repeator offset:	±600KHz
Repeator tone:	103.5Hz (adjustable), (E 1750Hz, crystal controlled)

3. RECEIVER

Frequency range:	142.000 - 148.995MHz (*144.000 - 149.995 MHz)
Receiver type:	Double superheterodyne
IF:	First 10.7MHz, second 455KHz
Sensitivity:	S/N ratio better than 35dB, 1uV, SINAD better than 12dB with .2uV input
Squelch sensitivity:	Better than .15uV
Bandwidth:	±5KHz/-6dB
Selectivity:	±12.5KHz/-60dB
Image ratio:	More than 70dB
Audio output:	More than 2w, 8 ohm load, THD 10%
RIT (Rec. incr. tune)	±1KHz steps, max one VFO step
Reverse:	Receive on transmit frequency

4. STANDARD ACCESSORIES INCLUDED

Microphone:		500 ohm, TM-2, tone encoder microphone with up/down buttons. (*DM-100 up/down microphone)
Power cable assembly:	1 piece,	with 7A cartridge fuse
Spare fuse:	1 "	7A
External speaker plug:	1 "	miniature phone plug type
Mounting bracket:	1 "	
Screws, etc:	4 "	4 x 12mm self tapping screw
	4 "	plain washer
	1 "	microphone mounting clip
	1 "	instruction manual
	1 "	circuit diagram, folded

NOTE: A receiver spur will be encountered at 144.000MHz (Harmonic of 9MHz standard frequency.)

KDK

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AMATEUR-WHOLESALE ELECTRONICS

MODIFICATION OF FM-144 FOR CAP AND MARS OPERATION

Introduction:

This modification will allow the FM-144 to be operated on set transmit and receive frequencies when the MHZ switch on the front panel is in the "P" position. The two frequencies may be split any distance apart and may be slightly out of the normal 2 meter amateur band.

Parts List:

3 - 11½" lengths of small diameter flexible hook-up wire.
1 - Length of 8½" small diameter hook-up wire.
Lengths of tubing (spaghetti).
10 - Switching diodes, IN4148 or IN914 or equivalent.
1 - 2.7 k ¼w resistor.
1 - 2N3904 transistor.
1 - 220 k ¼w resistor.

READ EACH STEP THROUGH BEFORE PERFORMING IT.

Step 1.

Remove case from FM-144. Remove four screws holding receiver board and remove board, propping it up on transmitter board so that the bottom of the power supply board (now exposed) can be worked on.

Step 2.

See Figure A. Using an X-acto knife or similar tool, cut circuit track at point A. Strip and tin both ends of each of the four lengths of hook-up wire. Solder one end of first wire to point X. Solder one end of second wire to point Y. Solder one end of third wire to point Z. Solder one end of the fourth wire to point W. (Note: the Power Booster module partially hides circuit pad Z - if difficulty is encountered soldering to point Z, four screws holding Power Booster module may be removed and module may be carefully pushed aside. Re-install module after connection is made).

Step 3.

Route four wires along edge of Power Booster Module. Bring wires up and over receiver board.

Step 4.

Note on a piece of paper color of wire corresponding to each point, X, Y, Z, and W.
Check all connections carefully for shorts or cold solder joints. Replace receiver board and tighten screws.

Step 5.

Route three wires (from X, Y, and Z) along top of transmitter and receiver boards, along with other wires already there. Feed the three wires alongside main frequency selector switch and through to other side. Route the fourth wire (from point W) along the opposite side of the chassis and between meter and front panel and through to other side. Turn FM-144 over.

Step 6.

See Fig. B. Unsolder green-white wire from priority feedthrough capacitor. Leave D26 soldered to feedthrough terminal. If a zero is desired in the one kHz place of the TRANSMIT frequency, leave the other end of D26 (cathode) soldered to position "a" on 0/5 kHz switch. If a five is desired in the last place (1 kHz) of the TRANSMIT frequency, solder the cathode of D26 to position "c" on 0/5 kHz switch. See Fig. C.

Now strip free end of wire from point X and solder to free end of green-white wire that was just removed from feedthrough. Wrap tape around joint and let this connection hang free.

Step 7.

Strip end of wire from point Z and solder to priority feedthrough terminal making sure not to short any solder to the metal collar (ground) surrounding feedthrough capacitor. The anode of D26 will also be connected to this terminal.

Step 8.

Remove cover from PLL module. You will notice several diodes connected from priority terminal to various other feedthrough terminals (See Fig. B). Program your desired TRANSMIT frequency by soldering the diodes to correct digits in your desired frequency. If the numeral you desire is not 1, 2, 4 or 8 it will be necessary to solder diodes to the terminals that add together to give you desired digit. For example, if 142.170 MHz is desired, one diode will suffice for the 1 MHz digit (2), one diode for the 100kHz digit (1) and three diodes for the 10 kHz digit (7=4 plus 2 plus 1). Note polarity of diodes; cathodes to terminals, anodes to priority terminal. Consult Page 11 of operator's manual for further explanation.

Step 9. SEE CHANGE

Unsolder the two white/red wires from the last feedthrough terminal on the outside of the PLL module. Solder both these two wires to the anode of a switching diode. Solder the cathode of this diode to the feedthrough terminal where the two white/red wires were just removed.

Step 10.

Check for good connections. Especially watch out for shorts to the collar surrounding terminal. Give any other wires that may be also connected to terminal tug to insure that they are well soldered. Replace cover on PLL.

ADDENDUM

Step 9.

Locate MHz switch on rear of front pannel. Locate terminal where white/red wire enters MHz switch. Desolder white/red wire from terminal. Solder the anode of a switching diode to the terminal on the MHz switch where the white/red wire was just desoldered. Solder the cathode of the diode to the free end of the white/red wire. Put some tape around the cathode end of the diode.

Step 11.

Now program your RECEIVE frequency, this time by soldering to the outside of terminals. It will be necessary to slip some tubing over the diode leads to keep them from shorting against anything. Observe polarity - Cathodes go to terminals, anodes of all RECEIVE frequency diodes are soldered together and will hang free.
Solder anode of one more diode to junction of anodes of other RECEIVE diodes and free end of this diode (cathode) will depend upon whether a "five" or a "zero" is desired in the one KHz place of the RECEIVE frequency. If a "zero" is desired, solder the free end of this diode to position "a" on 0/5 kHz switch. If a "five" is desired, solder cathode to position "c". See Fig. C.

Step 12.

Solder third wire from point Y on power supply module to the anodes of diodes soldered together in Step 10. Wrap connection with tape.

Step 13.

Now turn FM-144 over and remove four screws holding transmitter board. Push board aside and pop off bottom shield on PLL module. Locate R3 (1k resistor) from operator's manual pictorial and remove it. Replace it with R3A, 2.7k ¼w resistor. Replace shield. Replace transmitter board, making sure all wires are tucked neatly in their respective places.

Step 14.

Locate "unlock indicator" feedthrough capacitor on PLL. It is the very first feedthrough capacitor on the module and is the only one with a yellow lead connected to it. Cut the leads of the 220k ¼w resistor to approximately 3/16". Solder one end of resistor to "unlock indicator" feedthrough (both the resistor and yellow wire should now be connected to feedthrough). Cut the leads of the 2N3904 transistor to approximately 3/8". Solder the base of the transistor to the other end of the 220k resistor. The leads of the transistor are easily identified by the E, C, and B stamped on the case above each lead. Now solder the Emitter lead of the transistor to the metal shield box of the PLL. It should be soldered far down enough from the top edge of the box to permit the shield cover to clear the solder point. Now solder the wire coming from point W to the Collector of the transistor. Make sure none of the exposed connections of the transistor are touching each other or ground. Make sure no connection touches the metal collar surrounding feedthrough capacitor.

Step 15.

Make sure all diodes on outside of PLL module are free from touching each other and anything else. Tuck them neatly so that when case of FM-144 is slipped on, diodes will clear it. Replace case.

Operation: FM-144 will operate normally except when MHz switch is in the "P" position. When in "P" position, any frequency dialed in will be overridden and unit

will display pre-programmed receive frequency and will receive on that frequency. When the push-to-talk button is depressed, unit will display pre-programmed transmit frequency and will transmit on that frequency. Make sure Up/Down switch on front panel of FM-144 is in the SIMPLEX position during transmit on MARS or CAP frequency.

Notes: If only one frequency (simplex) is desired, follow manual instructions for pre-programming priority channel. 600 kHz splits may be used, as normal.

In order to obtain full-transmit power on frequencies outside the 2-meter band, or if no output is noticed on lowest MARS frequency, touch-up (peaking) of coil L7 in transmitter may be necessary. This is accomplished by melting wax in coil with soldering iron, switching to lowest desired frequency (with Up/Down switch in Simplex mode), keying transmitter and turning slug in L7 with a tuning tool until power comes up. BE CAREFUL NOT TO BREAK DELICATE SLUG IN COIL! Usually turning slug in a counterclockwise direction will bring power up. If your unit has been factory modified for all band coverage, retuning will probably not be necessary.

Transmitter will automatically delay output a fraction of a second to allow PLL to lock up over wide split.

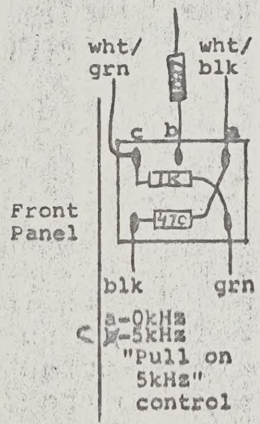

FIG. C

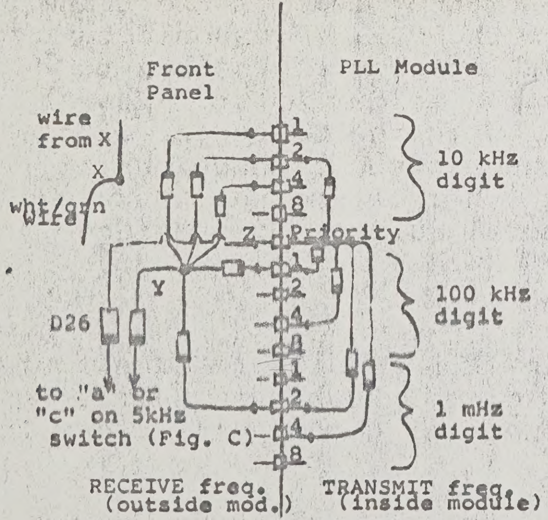

FIG. B

Note: Diodes shown connected
for 146.520 on TRANSMIT
and 142.170 on RECEIVE.

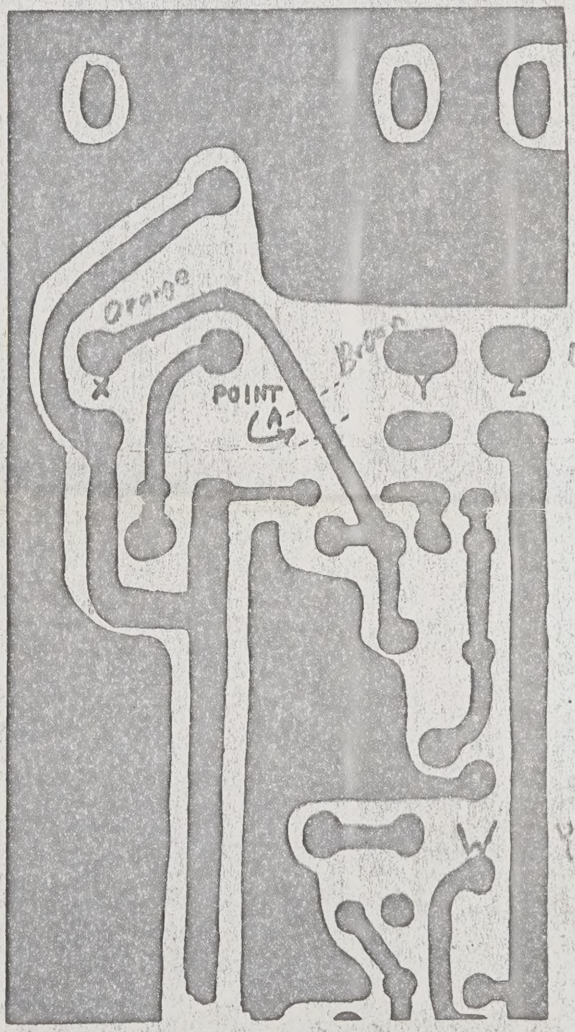

FIG. A